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California.

DEPARTMENT OF ENGINEERING.

REPORT

OF THE

~~STATE~~ Dept of ENGINEER

OF THE

STATE OF CALIFORNIA

May 11, 1907, to November 30, 1908

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1908.

DEPARTMENT OF ENGINEERING

REPORT
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STATE ENGINEER
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SACRAMENTO, CALIFORNIA,
OFFICE OF THE DEPARTMENT OF ENGINEERING,

November 30, 1908.

To His Excellency, JAMES N. GILLETT,
Governor of the State of California,

SIR: I herewith submit for your consideration the report of the Department of Engineering, covering the period from May 11, 1907, to November 30, 1908, as provided for in Chapter 183 of Statutes and Amendments, 1907.

Very respectfully,

NATHANIEL ELLERY,
State Engineer.

Attest:
H. S. MORROW, Secretary.

OFFICIAL DIRECTORY OF THE DEPARTMENT.

ADVISORY BOARD.

J. N. GILLET, *Governor*	Chairman.
W. V. STAFFORD	President, State Board of Harbor Commissioners.
F. W. HATCH	General Superintendent of State Hospitals.
NATHANIEL ELLERY	State Engineer.

RIVER CONSULTING BOARD.

ALEX. GORDON, *President.*

G. W. TATTERSON.

W. J. SMITH.

M. J. BOGGS.

E. S. BROWN.

OFFICE FORCE.

State Engineer	NATHANIEL ELLERY.
State Architect	GEORGE C. SELLON.
Assistant State Engineer	RALPH BARKER.
Assistant State Engineer	P. M. NORBOE.
Engineer's Draftsman	F. H. PERKINS.
Engineer's Draftsman	E. GOODWIN.
Architectural Draftsman	W. J. YOUNG.
Secretary and Stenographer	H. S. MORROW.
Porter	CHAS. PRINCE.

REPORT OF THE DEPARTMENT OF ENGINEERING.

The consolidation of the several engineering departments of the State and the addition of all the architectural work created an office, or department, the scope and value of which has scarcely been recognized. The legislature has enacted no plan that had a greater economic bearing than the one placing the State's technical work under one central control. There has been effected a saving of official salaries, a substantial saving of percentage on architectural fees, a considerable reduction in cost of material through large purchases applicable to various lines of work, and good fair prices on contract work obtained through the great amount of construction, and the proper application of the day's labor job to hold in check any tendency to excessive price. The monetary saving is very important, yet there are other matters connected with the inauguration of this Department that are as vitally important. The work can be specialized under experts of the various technical lines, thus giving the efficiency that a properly conducted business should have. The itemization of unit costs on work for the proper guidance of future expenditures and estimates of the State work, and a better class of inspection through the systemizing of reports and clerks who can check these reports from one inspector against another, places a State office under business methods.

There is no reason why the State should not handle its affairs on the same basis that an individual or concern would employ in their dealings. With the proper application of sufficient powers, and the upholding of the Department to attain this standard, there must result economies that under diversified management were lost sight of.

The Department was organized under adverse conditions, which has made the task of getting it into shape and in reliable working order a difficult one.

Owing to repairs on the Capitol, the office was separated on account of the lack of room into three divisions; one, the head office was in the Odd Fellows' Temple, Sacramento; another, an engineering branch, was located in the Elks' Building, Sacramento, and the third, or architectural branch, was located at No. 522 "K" street, Sacramento. This condition obtained from May 11, 1907, to December 1st of the same year, when we moved two of the offices and a part of the third one into the State Capitol. Some time later, about three months, the whole force was brought together. Five rooms on the third floor of the Capitol are wholly inadequate for the work of the Department, so the office has occupied three or four rooms on the fourth floor of the building, but was compelled to vacate these, except one used as a blue-print room, for use by the incoming legislature. The crowded condition of the office makes efficient operation decidedly difficult. This, with the fact that during a considerable period after entering the Capitol finishing work was progressing on the building, greatly interfered with our work. Thousands of sheets of drawings for building and engineering work are filed in the Department, as are numerous documents. No adequate furniture or space for office work or documentary files is now available. This situation should be relieved at an early date in order to fit the Department for its great amount of varied work.

In the commencement of a new department it is difficult to calculate exactly, or nearly, its needs. Since its beginning the lack of sufficient contingent appropriation and statutory office help has been very apparent. I wish to draw attention to the need of other statutory help and the reasons therefor. In grouping or segregating the employees it is necessary to make the following divisions: Engineering proper, general department, highway department, hydraulic department, and structural department.

Architectural department proper, composing three subdivisions; architectural draftsmen, mechanical men for heating, ventilating, plumbing, etc.; and the structural engineers. In devising and drafting the plans for the state building work, the Department has had but one architect and one statutory architectural draftsman. Other architectural draftsmen and designers, engineers and mechanical men of this division of the office, have been employed upon an hourly basis, *i. e.*, paid by the hour for their work. This method has proven very unsatisfactory, and should be remedied. There was no fund established for the drafting work of the buildings, except that under the appropriation to the particular institution where the erection was to take place. Here is a defect that should receive attention, and an appropriation should be made payable to the Department of Engineering for the purpose in order that we may pay the men promptly and thus avoid much discord. At the present time it is necessary to get out bills to each institution for which we are doing work, present the same for consideration at their regular board meetings, then properly pass through the State Board of Examiners, for audit, and finally reach the Department for distribution. In some instances money for salaries on this plan has been delayed three or four months. With the enormous business of this office one could not personally visit each State board and discuss to what extent the plans had advanced. These Boards naturally requested information in the matter. Further considerations of the duties devolving upon us makes it obligatory to have the office force rearranged to meet the great demand made. No statutory clerk is provided for compiling reports. This alone requires an efficient man. No person for blue printing is allowed; no cement tester is allowed, and the position of secretary and stenographer should be divided into two positions. To give some idea of the work handled by these people it is necessary to state their labors. Daily reports for segregation are received from every piece of the State's work, except that of the University of California, which, as yet, has not been brought under the Engineering Department. This information must be worked up in segregation sheets, some of which are published later in this report, and all estimates on contracts compiled from inspectors' reports. This information will prove of inestimable value to our State later, and should be profoundly carried on. A check can be had on each inspector, prices at various places may be compared, unit costs of various sorts of labor are immediately at hand, and fair estimating for and by the State is obtainable. We have established an electric blue printing machine at the office, and, in consequence, are saving to the State at least forty per cent on the cost of this work. It requires the continuous service of one man, and sometimes, as in the case of the San Jose Normal School plans, runs night and day. The extent of the work may be gleaned from a calculation of printing connected with those plans. There are 129 sheets of plans, about 32 inches by 45 inches, and we had demands for thirty-five sets of them, or 4,500 prints, or approximately 45,000 square feet of printing. I do not take up the very great task of printing for the Agnews Hospital reconstruction work, but shall endeavor to give a fair estimate for the need of such. a man. At present, all San Francisco harbor front work does not come to our office. This, however, as soon as the Agnews office work is completed, can be taken over and money saved the State.

One of the most vital and important branches under our direction is the cement testing laboratory, with some facilities for testing plasters and measuring voids in the aggregates of sand and rock and gravel for concrete work. Should a bad carload of cement get into a reinforced concrete structure it might endanger a great amount of money, and what is more important, many lives. With so general an application of cement for all kinds of construction it creates a positive demand for testing every batch used. The State can ill afford to pass this matter lightly, and should provide for the services of a man by statute. We have installed a complete cement testing plant, have samples taken promiscuously from each carload of cement sent to us, and before such cement is allowed in the structure it must pass the required specifications. I might here add, we have found some cement unfit for certain purposes we need it for, and we have therefore prevented its use. This alone has more than repaid for such a position. Every test made is recorded and filed away for reference, properly indexed. The far-reaching effect of this plant may be seen when it is suggested that manufacturers and sellers will use due care in selling these articles to the State and furnish nothing but what is up to standard. Our present testing laboratory has made *enough* cement tests to date to cover 50,000 barrels.

The position of secretary and stenographer is so totally inadequate for our needs that a glance will prove the necessity of a separation of the office, and the statutory office of a secretary be provided, also a stenographer. The present secretary and stenographer looks over practically all the construction claims of the State, besides keeping a set of books, paying all help which is on an hourly basis, makes out all Department claims, and performs numerous other duties. In addition to his services, we have had employed three stenographers, and at times were then in need of more.

Later will be given the costs of fees for architectural work of the department, when it must be noted that the costs of plans include stenographers services, clerk help, and all office work incidental thereto. It is, therefore, earnestly recommended and respectfully presented to the coming legislature for action that the Department of Engineering be provided with the following statutory officers: Two architectural draftsmen, one architectural designer, one mechanical engineer for plumbing, heating, and ventilating; one cement engineer, one blue printer, and two stenographers. It is further recommended that the State Architect have an increased salary, and his services be confined to the State work.

In connection with the request for a plumbing, heating, and ventilation engineer, it is fair to say that the State needs the services of such a man as much as any one employed by the department. The proper installation of these branches of work, as well as the steam and electric plants, is a most necessary thing. Through the improper installation of these the State may lose thousands upon thousands of dollars in construction, and then have an exorbitant maintenance expense. The operating expenses of the institutional work should be minimized, and it can be positively asserted that the foregoing work is one of the greatest factors in such expenditures.

The law creating the Department of Engineering, the same as all new laws of its scope, has some contradictions and defects which should at this session of the legislature be remedied. It is also suggested and recommended that the contract law enacted in 1876, and amended several different times, be stricken from the statute books and the salient points be incorporated in the Department of Engineering law. I therefore present the contract law as now constituted, and also the law creating the Department of Engineering, including the amendments thereto.

BUILDING LAW OF 1876, AS AMENDED TO DATE.

SECTION 1. That in all cases where the commissioners, directors, trustees, or other officer or officers, to whom is confided by law the duty of devising and superintending the erection, alteration, addition to, or improvement of any state institution, asylum or other improvement, erected, or now being erected, or to be erected, by the State, such commissioners, directors, trustees, or other officer or officers, before entering into any contract for the erection, alteration, addition to, or improvement of such institution, asylum, or other improvement, or for the supply of materials therefor, the aggregate cost of which erection, alteration or improvement, and materials therefor, exceed the sum of one thousand dollars, shall procure of the department of engineering a full, complete, and accurate plan or plans of such institution, asylum or other improvement, or of any addition to, or alteration or improvement thereof, in all its parts, showing all the necessary details of the work, together with working plans suitable for the use of the mechanics or other builders during the construction thereof, so drawn and represented as to be plain and easily understood; and also accurate bills, showing the exact amount of all the different kinds of materials necessary in the erection thereof, addition thereto, or in the alteration or improvement thereof, to accompany said plan or plans; and also full and complete specifications of the work to be done, showing the manner and style in which the same will be required to be done, giving such directions for the same as will enable any competent mechanic or other builder to carry them out, and afford the bidders all needful information to enable them to understand what will be required in the erection, addition to, alteration, or improvement of such institution, asylum, or other improvement; and to make, or cause to be made, a full, accurate, and complete estimate of each item of expense, and the entire aggregate cost of such institution, asylum, or other improvement, or of any addition to, alteration or improvement thereof, when completed.

SEC. 2. That such plans, drawings, representations, bills of materials and specifications of work, and estimates of the cost thereof, in detail and in the aggregate as required in the first section of this act to be obtained shall be, when made, submitted to the commissioners, directors, trustees, or other officer or officers of the institution for which said plans, drawings, representations, bills of material, and specifications of work are made and by him or them submitted to the Advisory Board of the Department of Engineering for their approval, and if approved by them, a copy thereof shall be filed and kept in the office of the Department of Engineering, and a copy thereof shall be deposited and safely kept in the office of the Controller of State.

SEC. 3. That after such plans, descriptions, bills of materials and specifications and estimates as are in this act required are made and approved, in accordance with the requirements of this act, it shall be and is hereby made the duty of such commissioners, directors, trustees or other officer or officers to whom the duty of devising and superintending the erection, addition to, alteration, or improvement of such institution, asylum, or other improvement as in this act provided, to give or cause to be given public notice of the time and place when and where sealed proposals will be received for performing the labor and furnishing the materials necessary to the erection of such institution, asylum, or other improvement, or for the adding to, altering, or improvement thereof, and a contract or contracts based on such sealed proposals will be made, which notice shall be published weekly for four consecutive weeks next preceding the day named for the making of such contract or contracts, in the paper having a general circulation in the county where the work is to be let, and in three papers specially representing the building trades, and having the largest circulation and published each in the cities of San Francisco, Los Angeles, and Sacramento, and shall state when and where such plan or plans, descriptions, bills, and specifications can be seen, and which shall be open to the public inspection at all business hours between the date of such notice and the making of such contract or contracts; *provided, however*, that the rates of said advertisements shall not exceed the regular advertising rates for similar matter, whether public or private, in such paper or papers. The aforesaid notice must state that bids will be received for the entire work and that bids will also be received for the performance of each of the following parts of said erection, addition, alteration or improvement, including the furnishing of materials and labor necessary therefor, viz.:

first, for the masonry work, including all brick, stone, terra cotta, and concrete work, and all necessary excavations, and filling; second, for the iron work; third, for the carpenter, electric, and glazing work; fourth, for the plastering work; fifth, for the plumbing and gas fitting work; sixth, for the heating work; seventh, for the tinning, galvanized iron, and slating work; eighth, for the painting and graining work.

SEC. 4. That on the day named in said public notice, said commissioners, directors, trustees, or officer or officers, as aforesaid, shall proceed to publicly open said sealed proposals, and shall award such contract or contracts for doing the work and furnishing the materials for the same to the lowest bidder, giving responsible bonds; *provided, always*, that no proposals shall be considered unless accompanied with a bond of said proposer, equal to ten per cent of his proposal, with sufficient sureties, conditioned that if said proposal shall be accepted the party proposing will duly enter into a proper contract, and faithfully perform his or their contract or contracts, in accordance with said proposal, and the plan or plans, specifications, and descriptions, which shall be and are hereby made a part of such contract or contracts; *and provided further*, that such contract or contracts shall not be binding on the State until they are submitted to the Attorney General, and by him found to be in accordance with the provisions of this act, and his certificate thereon to that effect made; *and provided further*, that if in the opinion of such commissioners, directors, trustees, or other officer or officers the acceptance of the lowest bid or bids shall not be for the best interests of the State, it may be lawful for them, with the written advice and consent of the Advisory Board of the Department of Engineering to accept such proposal or proposals opened, as in their opinion may be better for the interests of the State, or reject all proposals and advertise for others in the manner aforesaid. All contracts shall provide that such commissioners, directors, trustees, or other officer or officers may, as hereinafter provided, and on the conditions stated, make any change in the work or materials.

SEC. 5. That no change of the plan or plans, descriptions, bills of materials, or specifications which shall either increase or decrease the cost of said institution, asylum, building, or improvement, exceeding the sum of one thousand dollars, shall be made or allowed after they are once approved and filed with the Controller of State and in the office of the Department of Engineering, until such proposed change shall have received the approval of the Advisory Board of the Department of Engineering; and when so approved, the plan or plans of such change, with the description thereof, and the specifications of the work and bills of material, shall be filed with the Controller of State and in the office of the Department of Engineering, in the same manner as required before such change was made; and no allowance whatever shall be made for work performed or materials furnished under such change of plan or plans, or descriptions, or specifications, or bills of materials, unless, before such labor is performed and materials furnished, a contract or contracts therefor is made in writing, which contract or contracts shall show distinctly the nature of such change, and shall be subject to all the conditions and provisions herein imposed upon the original contracts, and be subject also to the approval of the Attorney General as hereinbefore provided; *provided*, that all changes in the contract exceeding five hundred dollars shall be by contracts in writing, with full specifications and estimates, and shall become a part of the original contract, and shall be filed with the Controller of State and in the office of the Department of Engineering, with the original contract; *and provided further*, that the amount of such change in the contract, plans, descriptions, bills of materials, or specifications shall not, in aggregate, increase the cost of construction of said institution, asylum, building, or improvement more than three per centum of the original contract price of cost.

SEC. 6. That no contract or contracts shall be made for the labor or material herein provided for at a price in excess of the entire estimate thereof in this act required to be made, and the entire contract or contracts shall not, including estimates of expenses for inspectors and otherwise, exceed in the aggregate the amount authorized by law for such institution, asylum, building, or other improvement, or such addition to, or alteration or improvement thereof, under the penalties of section ten of this act hereinafter provided.

Sec. 7. At the time or times named in the contract or contracts made and filed with the Controller of State, or which has been previously made and filed with him, in accordance with the provisions of this act, for payment to the person or persons with whom such contract or contracts had been made, it shall be and is hereby made the duty of the commissioners, directors, trustees, or other officer or officers, to whom is confided the duty of superintending the erection of such institution, asylum, building, or improvement, or adding to, altering, or improving the same, to make or cause to be made a full, accurate, and detailed estimate of the various kinds of labor performed and materials furnished under such contract or contracts, with the amount due for each kind of labor and materials, and the amount due in the aggregate, which estimate shall be based upon as actual measurement of the labor so performed and materials so furnished, which estimate shall, in all cases, give the amounts of the preceding estimate or estimates, and the amount of labor performed and materials furnished since the last estimate, which estimate or estimates so made, as in this act required, a copy of which shall be filed in the office of the Department of Engineering, shall be recorded in a book for that purpose to be provided and kept, or caused to be kept, by the said commissioners, directors, trustees, or other officer or officers, and a certified copy thereof, addressed to the Controller of State by the said commissioners, directors, trustees, or other officer or officers, or by such person as they may designate for that purpose, be delivered to the contractor or contractors, entitled thereto; *provided*, that upon all estimates or materials furnished and delivered, and not actually having entered into and become part of said institution, building, or other improvement, there shall not be paid, until the same shall be incorporated into and become a part of said institution, building, or other improvement, exceeding fifty per centum of such estimated value.

Sec. 8. It shall be the duty of the Controller of State, on the receipt of such estimate so certified and approved, to compare carefully the same with the contract or contracts under which labor was done or materials furnished, and if there had been any previous estimates, then with such estimates; and if, upon such comparison, he shall find such last-named estimate in all respects correct, he shall number the same, place it on file, and have a record thereof made, and give to the person or persons entitled thereto, taking his or their receipt therefor, a warrant on the Treasurer of State for the amount shown by such estimate or estimates to be due, less the amount of ten per centum thereon, which shall be retained as an additional security for the faithful performance of his or their contract or contracts, and shall be forfeited to the State in the event of a failure of such contractor or contractors to conform in good faith to the terms and conditions of such contract or contracts; but when the labor to be performed and materials furnished, under such contract or contracts, is performed and furnished, and a final estimate thereof made, the Controller of State shall include in the warrant or warrants for the amount of such last estimate the percentage retained on former estimates.

Sec. 9. The Treasurer of State shall pay the warrants issued by the Controller of State, under and by virtue of the provisions of this act, placing the same on file, and keeping a register of the names of the person or persons to whom such warrants are paid.

Sec. 10. Any commissioner, director, trustee, or other officer or person otherwise appointed, whose duty it is to superintend, in whole or in part, the erection of such institution, asylum, building, or improvement, or of adding to, altering, or the improvement thereof, or the making of the plans, descriptions, and specifications of the labor to be performed and materials to be furnished, as provided in this act, and the estimates of the cost thereof, or the estimates of the amount of labor done and materials furnished from time to time, under and in accordance with the terms and conditions of the contracts in this act authorized to be made, and the provisions of this act, who shall, in the performance of the duty herein imposed upon him or upon them, knowingly make, incomplete or fraudulent plans, drawings, bills of materials, specifications of work, or estimates of the cost thereof, or permit the work in any other manner than is prescribed in such plans, descriptions, and specifications, or with materials inferior to that required by such bills of materials, to the injury of the State; or shall knowingly make false estimates of the labor done or materials furnished, either in the quantity or price thereof, to the injury of the State; or any contractor, or any agent of any contractor or contractors, who shall knowingly permit materials to be used or work to be done inferior to, or in violation of, the contract of such contractor or contractors, to the injury of the State, shall be deemed and held guilty of a felony, and, upon conviction thereof, shall be confined in the State prison for not less than one year nor more than five years, and be liable to the State for double the amount the State may have lost, or be liable to lose, by reason thereof.

SEC. 11. It shall be the duty of the Attorney General to have charge of and direct all proceedings necessary to enforce the contracts authorized by this act and provisions of this act, against such person or persons as become liable to the penalties herein prescribed.

SEC. 12. Whenever, in the opinion of the commissioners. directors, trustees, or other officers charged with the duty of devising and superintending the erection, alteration, addition to, or improvement of any State institution, asylum, building, or other improvement under this act, or any law of this State, the work under any contract made in pursuance of this act, or any such law, is neglected by the contractor or contractors, or that the same is not prosecuted with diligence and force specified, meant, or intended in and by the terms of the contract, it shall be lawful for such commissioners, directors, trustees, or other officers to make a requisition upon such contractor or contractors for such additional specific force, or for such additional specific material, to be brought into the work under such contract, or to remove improper materials from the grounds, or in the judgment of such commissioners, directors, trustees, or other officers, such contract and its due and faithful fulfillment required; of which action of said board or other officers, due notice in writing of not less than five days, shall be served upon such contractor, or his or their agent having charge of the work. And if such contractor or contractors fail to comply with such requisition within fifteen days, it shall be lawful for said commissioners, directors, trustees, or other officers, with the consent, in writing, of the Advisory Board of the Department of Engineering, to employ upon such work the additional force, or supply the materials so specifically required as aforesaid, or such part of either as they may deem proper, and to remove improper materials from the grounds; and it shall be the duty of such commissioners, directors, trustees, or other officers, to make separate estimates of all such additional force or materials so employed or supplied as aforesaid, and which, being certified to by said commissioners, directors, trustees, or other officers, shall be paid by the Controller of State the same as is made out agreeably to section seven of this act, and the amount so paid shall be charged against said contractor or contractors, and deducted from his or their next, or any subsequent, estimate; or the same, or any part thereof, not paid as aforesaid, may be recovered by action from such contractor or contractors, and their sureties.

SEC. 13. In all contracts made under the provisions of this act, there shall be a provision in regard to the time when the whole, or any specified portion, of the work contemplated in said contract shall be completed, and also providing that for each and every day the same shall be delayed beyond such time or times so named, the said contractor or contractors shall forfeit and pay to the State a sum of money, to be fixed and determined in said contract, to be deducted from any payment or payments due, or to become due, to said contractor or contractors.

SEC. 14. All contracts now made, and not performed, for the erection, alteration, addition to, or improvement of, any State institution, asylum, building, or other improvement, shall, as far as practicable, be performed, completed, and enforced and settled for under this act, or may, by the consent of the contracting parties, be made to conform to, and proceed under, the provisions of this act.

SEC. 15. All acts and parts of acts in conflict with the provisions of this act are hereby repealed.

SEC. 16. This act shall take effect from and after its passage.

DEPARTMENT OF ENGINEERING LAW.

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. A department of and for the State of California, to be known as the Department of Engineering, is hereby created, to consist of an advisory board, composed of the Governor, as an ex officio member and chairman of said board, and a State Engineer, who shall be the chief executive officer of the department, the general Superintendent of State Hospitals, and the chairman of the State Board of Harbor Commissioners of San Francisco. The said department, its officers and employees, shall have and exercise the powers and duties hereinafter set forth and specified, and such as are or may be hereafter provided by law.

SEC. 1½. Upon this act becoming effective, the Governor, by and with the advice and consent of the Senate, shall appoint five persons, who shall be known as a Consulting Board to the Department of State Engineering upon all matters that affect irrigation, drainage, and river improvement. Such board shall be appointed from citizens of either the Sacramento or San Joaquin valleys. Such board shall meet at such times as the work requires, and shall meet at least once in two months. They may report to the advisory board upon all matters relating to irrigation, drainage, and river improvement, together with their conclusions thereon, and may render a report to the advisory board upon all plans for river improvements.

SEC. 2. Upon this act becoming effective the Governor, by and with the advice and consent of the Senate, shall appoint a competent civil engineer as the head of the Department of Engineering, and such person shall be known as the State Engineer. The State Engineer shall devote his entire time to the services of the State and shall not actively engage in any other pursuit while serving as such State official. He shall have charge of all the engineering and structural work of the department, and may receive by and through the approval of the Advisory Board such special assistance of a technical character, beyond the employees, hereinafter specified, as they shall allow for the proper conduct of the business of the department.

SEC 3. The State Engineer shall hold office for the term of four years from and after the date of qualification; *provided, however*, when a vacancy occurs in the office of State Engineer from whatever cause, the Governor shall fill, by appointment, said term for the unexpired part thereof only. Immediately after qualifying, the Advisory Board shall meet and organize and shall adopt a seal for the authentication of its acts and records.

SEC. 4. Within twenty days after receiving notice of appointment, the person appointed as State Engineer shall file a bond in the sum of twenty thousand dollars ($20,000) with at least two sufficient sureties thereon, or with a surety company of recognized standing for the faithful performance of his duties, which bond must be approved by the Governor and filed with the Secretary of State and he shall qualify by taking the oath of office as prescribed for other State officers.

SEC. 5. The office of the Department of Engineering shall be in the State capitol; and the Secretary of State shall assign to the department, for its use, such rooms as may be necessary for its accommodation. All of the regular meetings of the Advisory Board shall be held at such office. The said board may, however, hold such special meetings at such places as the duties of the Department, or the best interests of the State may require. The State Board of Harbor Commissioners for the port of San Francisco shall assign to the Department of Engineering proper rooms in the Ferry Building at San Francisco for the use of the State Engineer, one Assistant State Engineer, and the necessary office help.

SEC. 6. The Department of Engineering through and by the State Engineer shall have the power to appoint two assistant engineers, one State architect, three architectural draughtsmen, one architectural designer, two engineer's draughtsmen, one testing engineer, one mechanical engineer, one filing clerk, one blue printer, a secretary, two stenographers, and one porter, and such additional technical assistants and help as the Advisory Board may, in their judgment deem necessary, and to fix their salaries and compensation, who shall hold office at the pleasure of the appointive power, and who must be confirmed by the Advisory Board before proceeding with their duties. Such officers and employees shall not be eligible for appointment unless they possess special qualifications for and are competent to perform the duties devolving upon them, and they shall devote their entire time to the service of the Department.

SEC. 7. The Advisory Board shall meet at such times as the work of the Department may require and shall meet at least once in two months. Such board shall advise with the State Engineer and State Architect as necessity requires and may advise with the boards of managers or trustees of the various State institutions requiring engineering or structural work and with any State commission regarding all works wherein such commission may be interested. The Advisory Board shall approve all plans and specifications for all public work, and shall determine the kind, quality, and extent of all public work of the State. All boards of managers, trustees, and State commissions of State institutions shall apply to the Department of Engineering for plans and specifications for all public works coming under their charge, and before accepting any work done under contract shall have a certificate from the State Engineer, who shall examine and certify to its completion. All public work coming under the full control of the Department of Engineering may, upon the discretion of the Advisory Board, be either contracted for or done by day's labor. The Advisory Board shall have the power, on the approval of plans and specifications by the State Engineer, to direct whether any building or structure at any State institution shall be let by contract in part or in whole, or whether said building or structure shall be built by day's labor in part or in whole Whenever any public work to be done by the State is placed upon a day's labor basis, it is especially exempted from any law on or relating to contracts of the State. The full control of such day's labor work is placed under the Department of Engineering and said department shall do all things necessary to properly carry out the work. The Department of Engineering shall have the power to receive informal bids upon any subdivision of the day's labor work, and the State Engineer may, upon the approval of the Advisory Board, enter into an agreement for any such subdivisional work of the day's labor work.

Sec. 8. The full control of all public work being done or now completed by the Board of Public Works shall be assumed by the Department of Engineering, and all public work done by the State, except as otherwise expressly provided for by law, shall be under the full control of the said Department. It shall be the duty of the Department of Engineering, whenever required by the Advisory Board, to make examinations of lands subject to inundation and overflow by flood waters and of the waters causing such inundation or overflow and plans and estimates of the cost for works to regulate and control such flood waters. All matters of drainage, and improving and rectifying river channels, and other work on any river or slough flowing into San Francisco Bay, San Pablo Bay, and Suisun Bay, and also the tide waters flowing into said bays, shall be placed under the management and control of the Department of Engineering whenever the law provides therefor. The Department of Engineering shall have charge of all expenditures, unless otherwise provided by law, for all public works relating to general river and harbor improvements, including reclamation and drainage of lands. It may purchase, construct, and operate one or more dredges, or any other needed appliances to promote or properly carry out the work of the Department. The State Engineer, in the name of the State of California, may obtain or condemn any right of way necessary for any construction herein named, and shall proceed, if necessary, to condemn under the terms of the Code of Civil Procedure relating to such proceedings. The Department shall have the power to employ such additional help for the performance of the work of this section as the Advisory Board shall order, and all money now appropriated to the Board of Public Works and remaining unexpended shall be used for the purposes intended by the law, by the Department of Engineering, and the State Controller shall transfer said funds to the credit of the Department of Engineering. Wherever under any statutes of this State any duty or obligation, the performance of which is imposed upon the Commissioner of Public Works or the Auditing Board to the Commissioner of Public Works, the same shall be assumed and the performance of the same shall devolve upon the Department of Engineering.

Sec. 9. The Department of Engineering shall take full possession and control of all roads which have been declared State highways, enumerated as follows: The Lake Tahoe wagon road, the Sonora and Mono road, the Mono Lake Basin road, and all other State highways which may hereafter be constructed, and all public work being done or now completed by the Department of Highways. All expenditures by the State for highway purposes, except as otherwise hereafter provided by law, shall be under the full charge of the Department of Engineering, and all moneys appropriated for such purpose shall be made payable upon the proper order of said Department and shall be audited by the State Board of Examiners. The Department of Engineering, through its State Engineer, shall have the power to obtain or condemn necessary rights of way for the hange of any existing State highway or for any road placed under the Department's charge by law unless otherwise provided. It shall have power to alter or change the route of a road, and shall do all things necessary, and obtain all tools and implements required to properly care for and manage the roads under the charge of the Department. The Department may, in its discretion, appoint superintendents of the State highways, who shall hold office at the pleasure of the appointive power. They shall, however, be confirmed by the Advisory Board, and shall be specially qualified in road work. All unexpended balances of money now existing by law for improvements or maintenance of whatever kind under the Department of Highways, and the Lake Tahoe Wagon Road Commissioner, shall be placed under the control of the Department of Engineering, and the State Controller shall transfer said funds to the credit of the Department of Engineering. Wherever under any statutes of this State any duty or obligation, the performance of which is imposed upon the Department of Highways, the same shall be assumed, and the performance of the same shall devolve, upon the the Department of Engineering.

Sec. 10. The Department of Engineering shall make examination into existing highway conditions in the State of California, and shall, furthermore, make such investigations within the State as will put at the service of the State the most approved methods of highway improvement. It shall supply, on request, without charge, any information relative to highways required by any county or district official having care of and authority over highways within this State. It shall collect and collate data relating to the geological formation of the State in so far as it relates to material suitable for highway construction, and make analyses and tests of such material as it may deem suitable for highway uses, with the view of determining the value of the same for such purposes. All data so collected, together with such other matters of value or interest to the people of the State, shall be published in bulletins, or upon maps or diagrams, or in other proper form, or in the biennial report of the Department, as in its discretion shall determine. The department shall prepare and adopt styles and forms of books for use by officials, in which to keep account of the expenditure of highway money and all other records or proceedings relating to highways. It shall prepare such forms as may be necessary for use in connection with opening, abandoning, altering, locating, constructing, maintaining, obtaining title to, or otherwise relating to proposed State highways; and such books and forms, when so adopted, shall be the standard for use in the State. Copies of them shall be forwarded to the various officials who are charged with keeping or using the same, and such officials shall immediately prepare books and forms after the style shown by such standard, and shall thereafter use them exclusively for the purposes for which they are intended. It shall be the duty of the Department to adopt such general forms for the surveying of State highways, mapping, and keeping of the notes thereof, and the permanent marking of the same on the ground, as it shall deem necessary, and shall issue instructions defining such general forms and markings to the person having charge of the making of such surveys; and it shall thereafter be the duty of such persons to follow the methods prescribed in such instructions. The Department of Engineering, in performance of its duties, shall have the power to call upon any State, county, or district official to furnish it with any information contained in his office which relates to or is in any way necessary to the proper performance of the work of said Department; and it is hereby made the duty of such officials to furnish such information without cost.

Sec. 11. All architectural work of the Department shall be under the charge of the State Architect, and it shall be the duty of the Department of Engineering to make plans and specifications and estimates for all State building work. The State Architect shall, in company with the State Engineer, visit and inspect all completed work and shall certify to the State Engineer its proper or improper completion. The State Architect shall have general charge, under the State Engineer, of the erection of all buildings and the Department of Engineering must have an inspector at each building during the whole time of its construction.

Sec. 12. One Assistant State Engineer shall be assigned to the State Board of Harbor Commissioners at San Francisco, where he shall have an office. He shall prepare such engineering plans and specifications as said board may direct, and if adopted and the work ordered to be done, must superintend its construceion. He must give constant attention to the condition of the seawall and thoroughfare, of the sheds, wharves, piers, and landings, of the streets or parts thereof under the jurisdiction of the board and when repairs are needed, must forthwith report to the board in writing their nature and extent, and if ordered by the board, must have the same done at once. He must keep himself informed as to the depth of water in the various docks and slips, and report to the board from to time what dredging is required. He must keep a register properly indexed, showing the date, place, and character of every piece of work done and dock dredged, when begun and finished, with proper descriptions and drawings. He shall do all engineering work, under the direct supervision of the State Engineer, required by the said Board of Harbor Commissioners. Said Assistant Engineer shall be subject to the full control, at all times, of the State Engineer, and a copy of all work under his charge as Assistant Engineer shall be filed in the office of the Department of Engineering at Sacramento. A complete record of cost, in detail, of all work done under the supervision of this assistant engineer shall be filed with the Department of Engineering upon the completion thereof. One engineer's draughtsman shall be assigned to the said harbor board by the State Engineer, and the Advisory Board of the Department of Engineering shall employ such field and other assistants to the foregoing Assistant State Engineer as may be necessary and such field and other assistants shall be paid from the San Francisco harbor improvement fund.

Sec. 13. All coöperative engineering work now existing or to be engaged in by the State with the United States Government shall be placed under the Department of Engineering. All plans, estimates, and specifications shall be approved by the State Engineer, and the Advisory Board shall have full power to determine the kind, quality, and extent of such work under coöperation with said Government before entering into agreement with said Government for such work. All unexpended moneys provided for by law on the aforesaid coöperative bases shall be expressly placed under the full control of the Department of Engineering, and the State Controller shall transfer such funds to the credit of the said Department. Hereafter plans, estimates, and specifications for such work shall be filed in the office of the said Department.

Sec. 14. It shall be the duty of the State Engineer to consult and advise with the members of the Corps of Engineers of the United States Army comprising the California Débris Commission (created by act of Congress approved March first, eighteen hundred and ninety-three), in relation to the construction of works for the restraining and impounding of débris resulting from mining operations, natural erosion, or other causes; and it shall be his duty to examine such works and to report the result of such examination to the Advisory Board. Said State Engineer is further authorized and directed to consult and advise with said "California Débris Commission" in relation to any and all plans and specifications that may have been or may hereafter be prepared or adopted by said "California Débris Commission," for the construction of such restraining or impounding works, and said State Engineer shall file a copy of all such plans and specifications in the office of the Department. Whenever the Advisory Board approves said plans and specifications, the State Engineer shall notify the "California Débris Commission." Whenever said "California Débris Commission" or the Government of the United States shall have entered into any contract for the construction of works for the purposes described in this act, in pursuance of plans and specifications that have been theretofore approved by the Advisory Board as in this act provided, it shall then be the duty of the State Engineer to cause such work to be carefully inspected during the progress of their construction and to keep a record of the result of such inspection. Said State Engineer shall also from time to time, during the progress of the construction of such works, when requested so to do by the said "California Débris Commission," present his claims to the State Board of Examiners for an amount equal to one half the purchase price of any site or sites necessary for the construction of said works; *provided*, that the purchase of said site or sites shall have been first approved by the Advisory Board. All unexpended balances of money provided by law for the work under the Débris Commissioner shall be placed to the credit of the Department of Engineering by the State Controller. Whenever under any statutes of the State any duty or obligation the performance of which is imposed upon the Débris Commissioner, the same shall be assumed and the performance of the same shall devolve upon the Department of Engineering.

SEC. 15. When in his judgment it is deemed necessary, the State Engineer, subject to the approval of the Advisory Board, shall employ such assistance on the public work of the State or on public work at any State institution as may be necessary for the proper discharge of his duties, and shall under like restrictions, have the authority to purchase such supplies, instruments, tools, and conveniences as may be necessary for the proper discharge of the duties of the Department of Engineering. All employees of the Department of Engineering, when employed upon public work at or for any State institution in this State shall be paid, unless otherwise provided, from the funds of the State institution at or for which such work is performed. In all other cases, such employees shall be paid by the Department of Engineering. All inspectors employed by the State Engineer on any public work shall render to the State Engineer a full, true, and correct report of the kind, manner and progress of all work upon which he is such inspector. Any inspector who renders a false report, knowing the same to be false, shall be guilty of a felony. It shall be the duty of the State Engineer to keep a full, true, and correct detailed account of the cost of all work done under the control of the department of Engineering, and with the consent of the Advisory Board may employ a clerk for the proper compiling thereof. Such account shall be always open to the inspection of the public.

SEC. 16. The State Engineer shall prepare biennial reports which shall be submitted to the Governor at least thirty days before each session of the Legislature. Said report shall embrace the work and investigations of the Department under his charge for the previous two years, together with such recommendations for changes in the laws affecting the Department as he may deem advisable, and shall suggest and recommend changes relating to the road systems or administration within the State. It shall be the duty of the State Printer to print all reports, bulletins, or other matter, and furnish any other necessary illustrations or diagram therefor as the Department may deem necessary, all of which shall, however, be subject to the approval of the State Board of Examiners.

SEC. 17. The State Engineer shall receive the sum of four thousand eight hundred dollars ($4,800) per annum; each Assistant State Engineer shall receive three thousand six hundred dollars ($3,600) per annum; the State Architect shall receive four thousand eight hundred dollars ($4,800) per annum; each draughtsman shall receive two thousand dollars ($2,000) per annum; the architectural designer shall receive two thousand four hundred dollars ($2,400) per annum; the mechanical engineer shall receive two thousand four hundred ($2,400) dollars per annum; the testing engineer twenty-one hundred dollars ($2,100) per annum; the filing clerk eighteen hundred dollars ($1,800) per annum; the secretary twenty-one hundred dollars ($2,100) per annum; the printer nine hundred dollars ($900) per annum; each stenographer twelve hundred ($1,200) dollars per annum; and the porter shall receive four hundred and eighty dollars ($480) per annum. Such salaries shall be paid at the same time and in the same manner as are the salaries of other State officers. The two Assistant State Engineers and the State Architect shall each furnish the State with a bond in the sum of ten thousand dollars ($10,000) for the faithful performance of their duties. Said bonds must be approved by the Governor of the State of California and filed in the office of the Secretary of State. Each and every one of the above mentioned officers shall take the oath of office as prescribed for other State officers. The members of the Advisory Board, the State Engineer and the officers and employees of the Department of Engineering shall be allowed their necessary traveling expenses while engaged in the discharge of their duties within the State.

SEC. 18. The State Board of Examiners shall audit all bills or claims incurred by the Department of Engineering and the State Engineer shall present claims to said board for all expenditures directly under his charge. The Attorney General of the State shall be the legal adviser of the Department of Engineering and the said Department shall call upon the Attorney General of the State for all such legal advice and services as the discharge of its duties may require.

SEC. 19. For the purpose of carrying out the provisions of this act, the sum of ten thousand dollars ($10,000) is hereby appropriated to pay the salaries of the officers and employees and the other expenses of said Department for the remainder of the fifty-eighth fiscal year.

SEC. 20. It shall be the duty of the Auditing Board to the Commissioner of Public Works, the Commissioner of Public Works, the State Highway Commissioner, the Débris Commissioner, and the Lake Tahoe Wagon Road Commissioner to transfer to the State Controller all of the property, books, reports, and papers and maps of every description which is State property, and the said Controller shall transfer all of said things and property to the Department of Engineering.

SEC. 21. An act entitled "An act creating a Commissioner of Public Works, defining his duties and powers and fixing his compensation," approved February ninth, nineteen hundred, and all acts or parts of acts amendatory thereof are hereby expressly repealed.

SEC. 22. An act entitled "An act to create a Department of Highways for the State of California, to define its duties and powers, to provide for the appointment of officers and employees thereof, and to provide for the compensation of said officers and employees, and for the additional expenses of said Department, and to make an appropriation therefor for the remainder of the forty-eighth fiscal year," approved April first, eighteen hundred and ninety-seven, is hereby expressly repealed.

SEC. 23. An act entitled "An act providing for the appointment of an Auditing Board to the Commissioner of Public Works, authorizing and directing him and them to perform certain duties relating to drainage, to purchase machinery, tools, dredges, and appliances therefor, to improve and rectify water channels, to erect works necessary and incident to said drainage, to condemn land and property for the purpose aforesaid, making certain acts a felony, and making an appropriation of money for the purposes of this act," approved March seventeenth, eighteen hundred and ninety-seven, and all acts or parts of acts amendatory thereof are hereby expressly repealed.

SEC. 24. An act entitled "An act to provide for the appointment, duties, and compensation of a Débris Commissioner, and to make an appropriation to be expended under his directions in the discharge of his duties as such commissioner," approved March twenty-fourth, eighteen hundred and ninety-three, and all acts or parts of acts amendatory thereof are hereby expressly repealed.

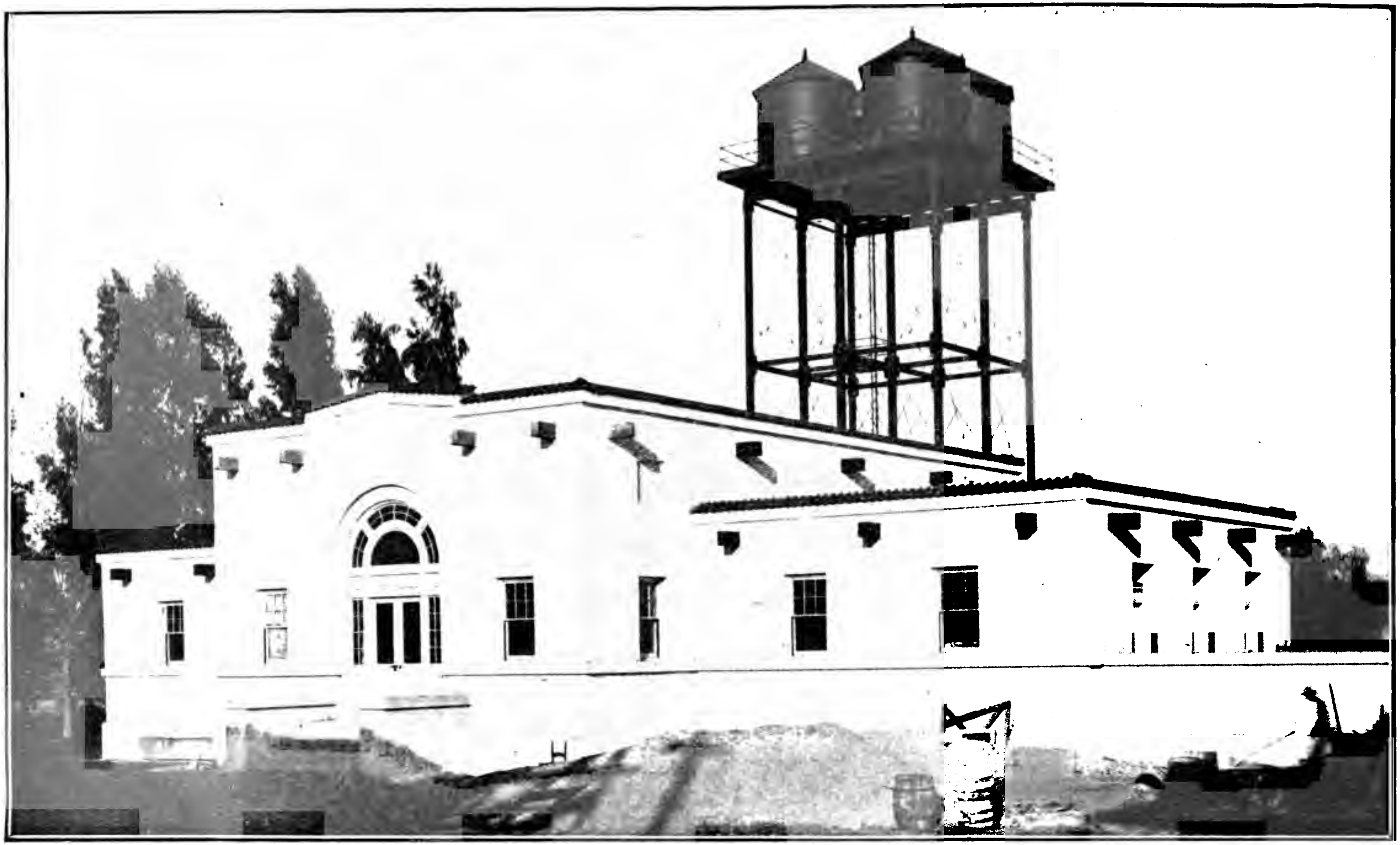
SEC. 25. An act entitled "An act to create the office of Lake Tahoe Wagon Road Commission, providing the term of office and compensation of such commissioner, defining his duties, and making an appropriation for the salary and expenditures provided for and authorized by this act," approved April first, eighteen hundred and ninety-seven, and all acts or parts of acts amendatory thereof are hereby expressly repealed.

SEC. 26. All acts or parts of acts in conflict with the provisions of this act are hereby repealed.

I firmly believe the abolition of the contract law of 1876, and its amendments, and the enactments of the features of it included under the Engineering Department will greatly facilitate the transaction of the work of construction and amply safeguard all the interests of the State. In the advocacy of the increased number of statutory offices, it will suffice to say their pay now comes from special appropriations and would, if enacted into law, come under the general salary fund. The cost of the services of these men, except the cement tester, is now charged to the cost of the plans, bills of materials, estimates, and specification for the particular work they handle. The cost to the State is the same either way the men are employed, but the business of the office can be greatly facilitated by regular employment of this additional help, without any extra cost.

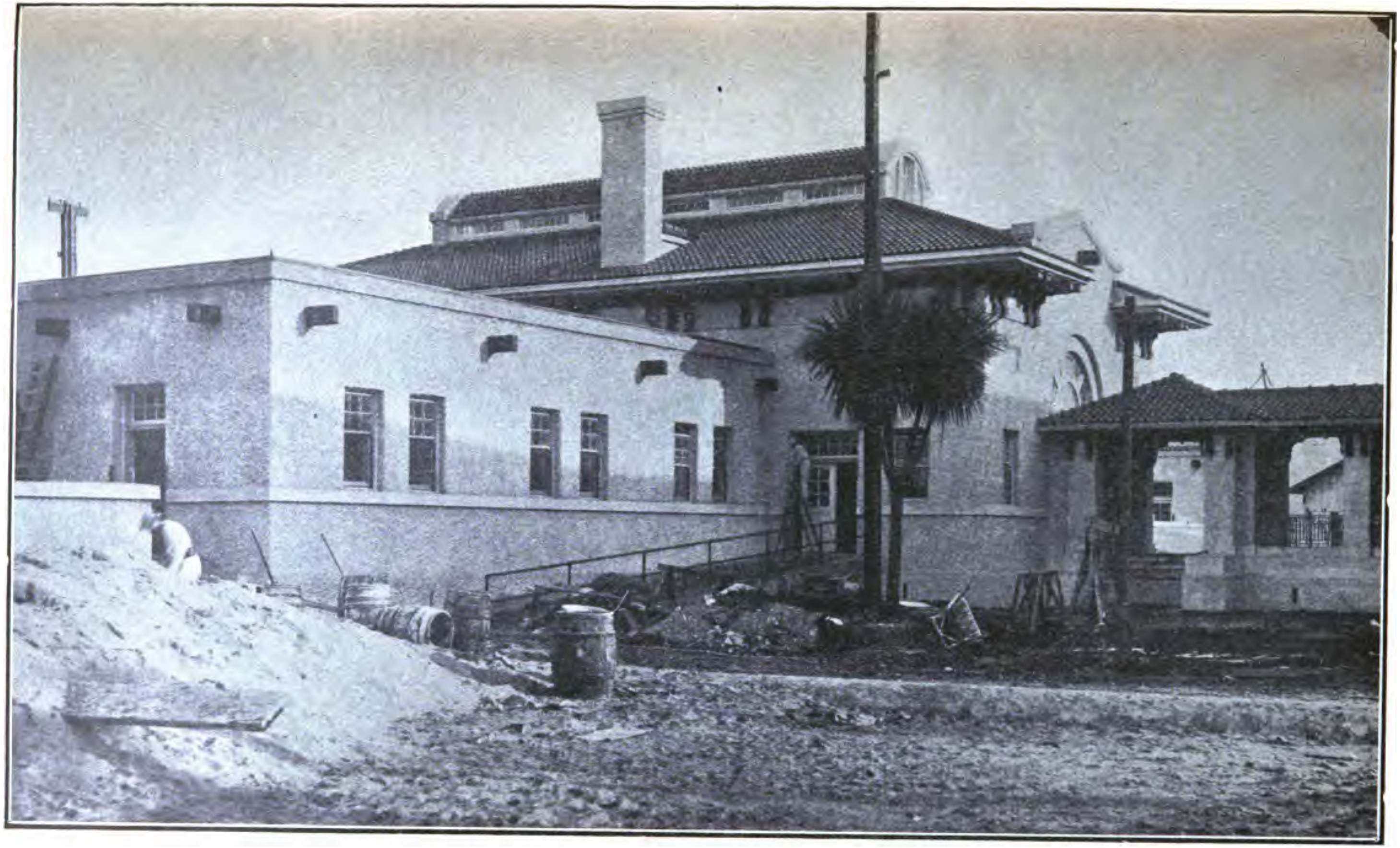
AGNEWS STATE HOSPITAL.

At the Agnews State Hospital the old buildings were destroyed by the earthquake, the mechanical plant and the water tower being about the only structures that remained standing of any value. After many

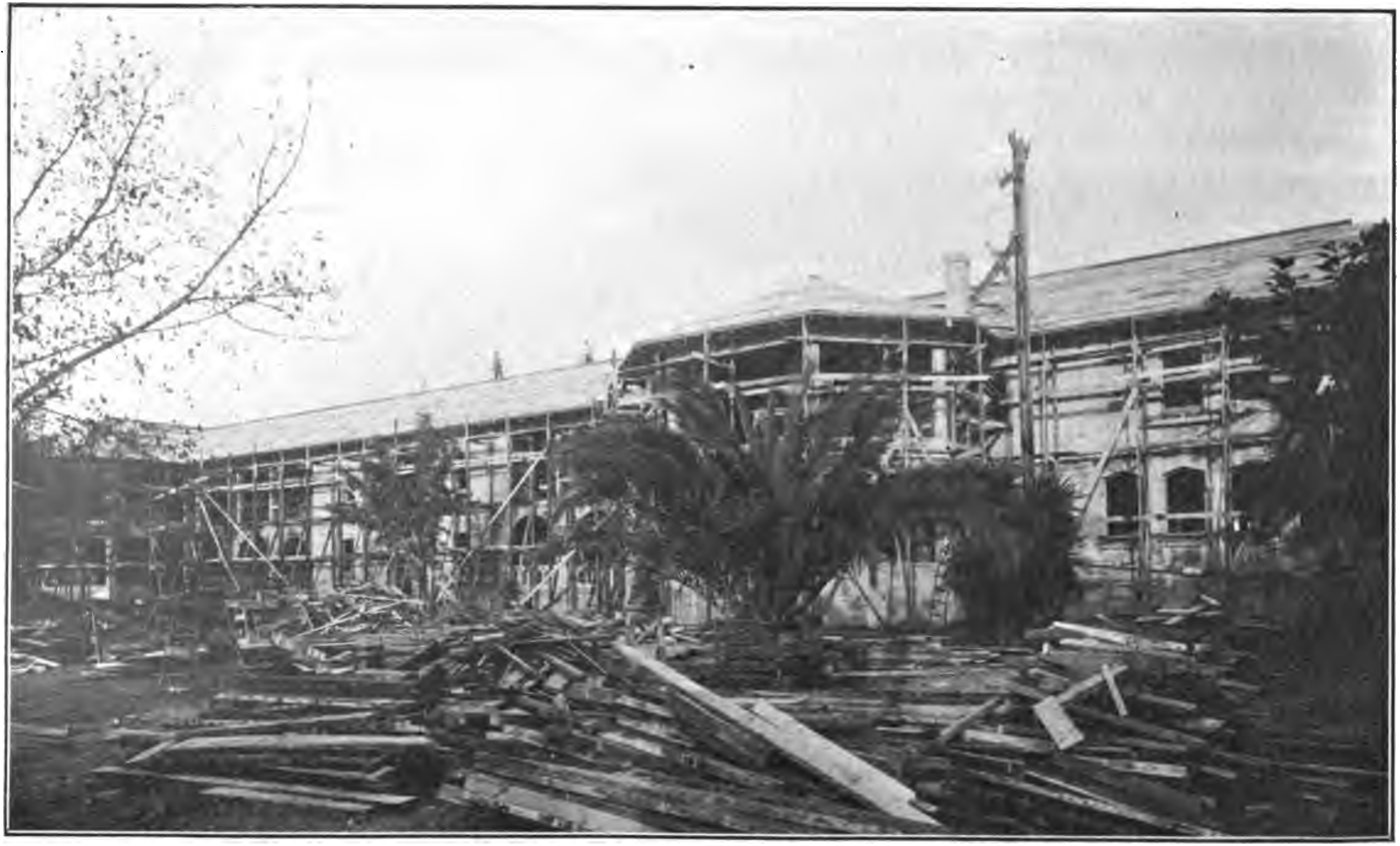


NEW COMMISSARY BUILDING, AGNEWS STATE HOSPITAL.

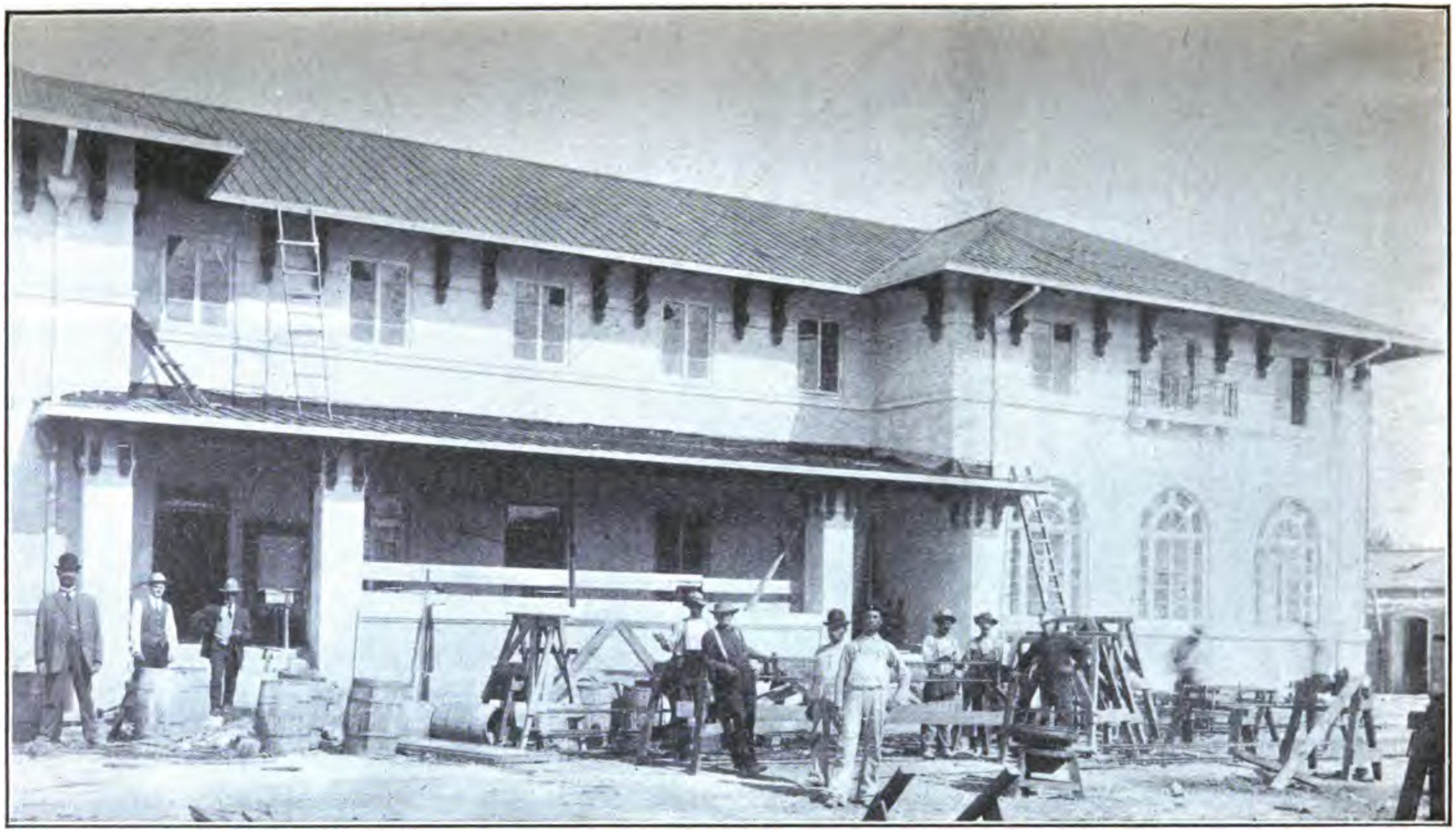
consultations with the Board of Managers and the superintendent it was decided to rebuild the institution on what is known as the cottage plan. A complete mechanical layout has been designed for sewers, underground concrete conduits, including gas pipes, steam pipes, wiring, water pipes, etc., the installation of a new power plant, including steam boilers, engines, and electric generators. This plan included a complete arrangement for a system of underground piping, etc. The buildings have been arranged with the power plant in the central and rear part of the group. Extending on either side of the power plant are two two-story reinforced concrete buildings; one for the violent and disturbed patients, and the other for the demented patients. Taking the boiler plant and drawing an axial line to the main avenue of the grounds divides the buildings as to male and female occupancy. Directly in front of the power house is a group of three buildings, the kitchen, the commissary, and the bakery buildings, all made of reinforced brick construction. In front of these one-story buildings is placed the main dining building of two stories, built of reinforced concrete. Continuing to the front, next comes the treatment building, in the center of a group of three and a two-story reinforced concrete building on either side known as the receiving building. This group forms the rear end of the minor axis of the ellipse and is composed of the largest buildings at the institution. From these buildings toward the front on one side the male and on the other side the female patients—the other structures come in the order mentioned. Two buildings for infirm, one story in height, two buildings for quiet and medium, two buildings for workers, two for convalescent patients, two nurses' home buildings, one administration building and opposite it, enclosing the ellipse, an assembly hall. All of these, unless otherwise stated, are two stories in height, constructed of reinforced concrete. Up the avenue will be the superintendent's house, and opposite it, on the avenue, the assistant physician's house. These last two buildings will probably be frame structures. In all, the Agnews State Hospital will be finely equipped with twenty-five modern, well-constructed buildings, housing between 1,100 and 1,200 patients, and a mechanical plant worked out for maximum economy of operation. The work is progressing very well and very nearly all of the $800,000 appropriated by the last legislature has been used or is under contract. At the date of this writing, the bakery building and the commissary building are completed, and the dining building and the kitchen are very nearly completed. In the two receiving buildings, all concrete is poured, as is also the case of the two buildings for demented patients. The buildings for the infirm are nearly completed, and the two buildings for the quiet and medium patients and the two for the violent and disturbed patients are under very good headway. This list includes fourteen buildings under con-



NEW KITCHEN BUILDING, AGNEWS STATE HOSPITAL.



NEW RECEIVING BUILDING, AGNEWS STATE HOSPITAL.



DINING HALL, AGNEWS STATE HOSPITAL, DURING CONSTRUCTION.

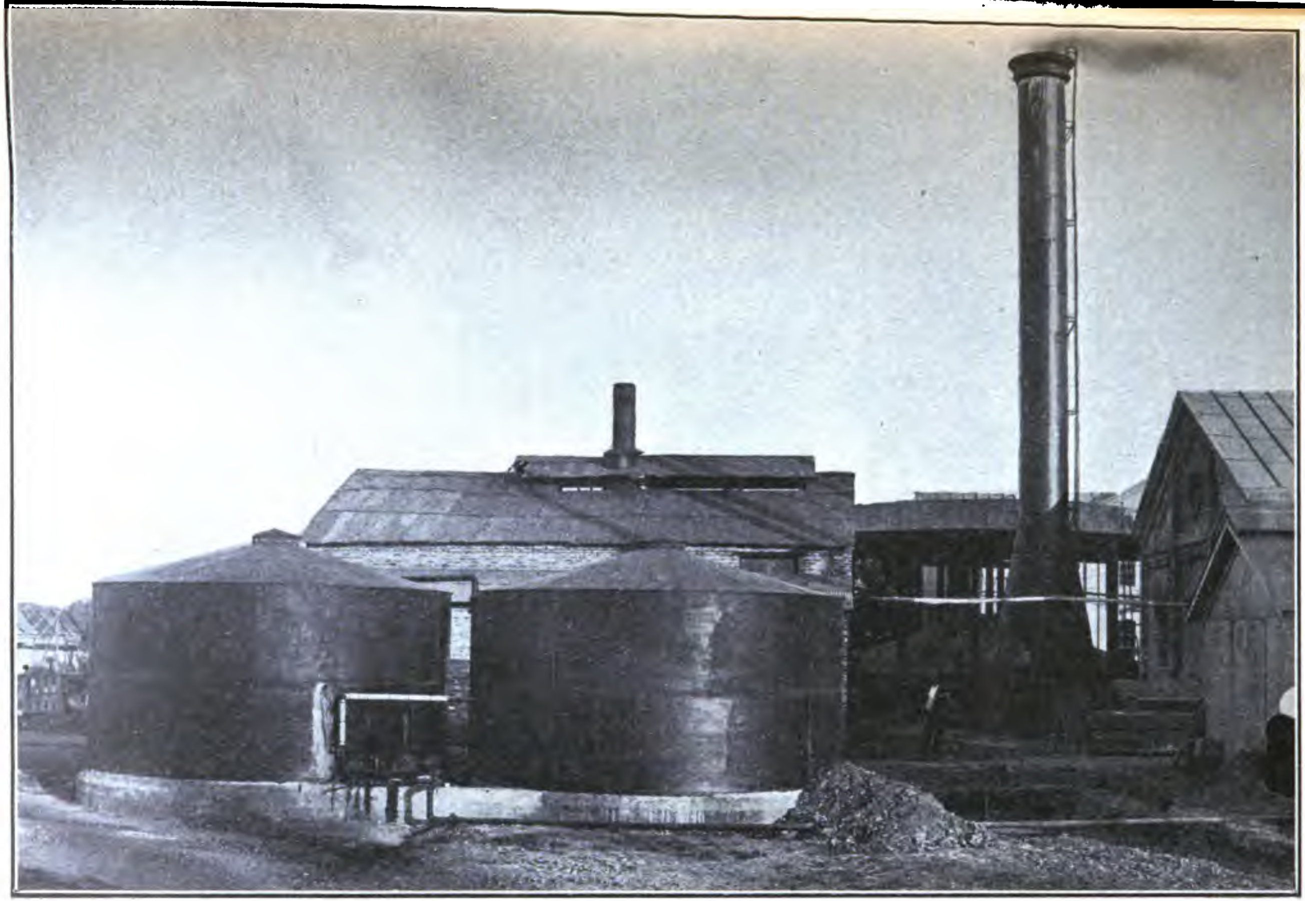
struction or constructed. For a list of the buildings, giving cost and other information, see the following table of building work. In addition to the work outlined above, the department erected a self-supporting steel smokestack and two 20,000-gallons steel oil tanks on the grounds. The two tanks complete with concrete foundations and pump cost by contract $2,800, while the stack which is lined with vitrobestos, a non-corrosive substance, cost by contract $2,536. There were also two iron stairways erected on the ends of the laundry building at a cost of $1,079. The estimate for the construction of the complete work as outlined by the plans is for $1,300,000. Through the intervention of the Governor, as chairman of the Advisory Board, about $200,000 was saved in the construction of two-story buildings instead of one-story heights as at first presented.

HOME FOR THE CARE AND TRAINING OF FEEBLE-MINDED CHILDREN.

During 1907 there was appropriated $75,000 for a new administration building, $20,000 for two cottages for epileptics, and $5,000 for a dairy barn. The design for a new manor house and nursery barracks came up to the department with the designs covering the appropriations. In some instances, we handled work started before the department was organized, but in such cases our record is incomplete. This was so with the cottage for girls. The administration building is to be three stories of reinforced brick construction, to correspond in outward appearance with the remainder of the main institutional building, with which it is directly connected. The two cottages and dairy barn are frame buildings, with concrete foundations. These structures are about completed, and the administration building is about one half complete. At this institution there are many small detail matters that have been cared for. All work on the structures given has been by day's labor, and is outlined for cost by the table given for all buildings.

SAN JOSE NORMAL SCHOOL BUILDING.

After being condemned, the old structure has been completly wrecked and the design for a handsome new building, quadrangular in shape, made of reinforced concrete, has been made. The lack of sufficient funds to obtain the class and size of building desired by the Board of Trustees delayed very materially in the final completion of the plans. Different sketches were submitted for their approval, but the first scheme, which is the one now adopted, received their sanction, with the understanding we so design the structure that the auditorium could be left off temporarily, if necessary, without damage to the appearance of the building as a whole. Immediately after getting the final expression from the board the Department proceeded on the drawings. They were finished complete with and without an auditorium, and also a new power



STACK AND TANKS ERECTED BY DEPARTMENT. AGNEWS STATE HOSPITAL.

plant, which is demanded by the new building. In no case is the structure, except the tower, which is heavily reinforced, to be over two stories in height. A detailed estimate of cost is being now made by the Department, and will when finished give complete figures.

THE STATE HOSPITALS—MENDOCINO, NAPA, STOCKTON, AND SOUTHERN CALIFORNIA.

For each of these four institutions there has been designed a receiving building for the treatment of the insane. These, in all instances, are one story in height, made of reinforced concrete, and with the exception of Southern California Hospital, are under construction on a day's labor basis. By this method at Napa, Stockton, and Mendocino we are using many patients, thus cutting the cost to the State down nearly one half. At the Napa Hospital we are constructing one wing and the central part of the building, thus leaving another wing. The complete design of this structure we have ready for some future time.

At the Stockton Hospital, we have well under way a one-story reinforced concrete structure, built largely by patients. This is also the case at the Mendocino Hospital, but the building here is much smaller and of cheaper construction. The appropriation for this cottage was $30,000.

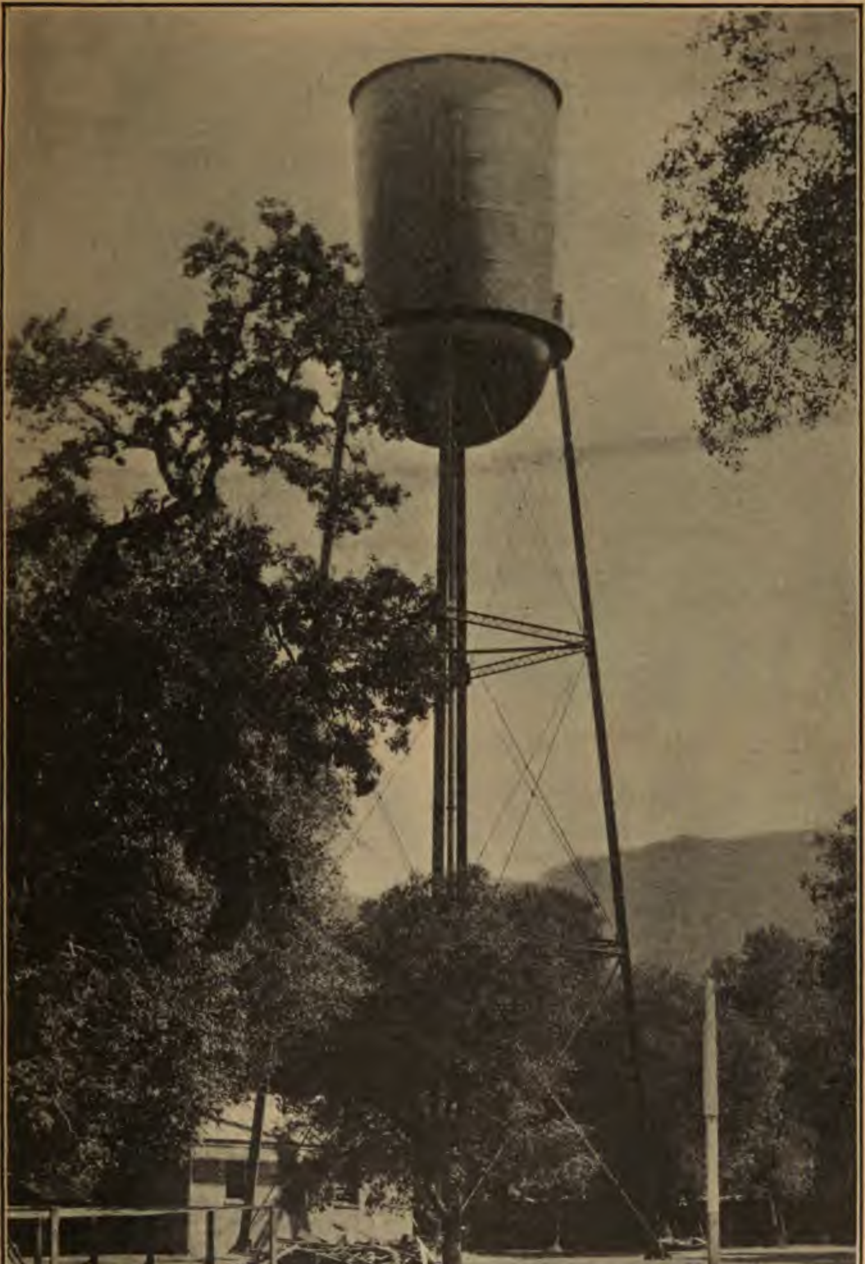
The receiving building for the Southern California State Hospital has not yet been started. The plans have undergone revision several times in order to get the cost of this building within the appropriation of $43,000. The interior work has been materially cheapened, that this building may be done by contract. The walls and floors are now designed of concrete and the interior walls are wood studding.

MENDOCINO STATE HOSPITAL.

Besides the receiving building being erected at this institution by day's labor, three small pavilions for patients were designed by this Department and built by the institution. On November 4, 1907, a contract was entered into with the Chicago Bridge and Iron Works for the erection of a steel water tower and steel tank. The tower of this structure is 139 feet above the ground and the tank's capacity is 100,000 gallons. This tank was built to replace the water tanks in the main building. This is a modern and well-built structure, after plans designed by the Department, thoroughly stayed latterally against horizontal forces.

NAPA STATE HOSPITAL.

A group of detached cottages, to accommodate the great overflow of population at this institution, was designed, containing four dormitories and a central day room building. These structures are made one story in height and constructed of brick. Three of them have been almost entirely built by patient labor, thus saving a considerable sum of money



STEEL TOWER AND TANK, MENDOCINO STATE HOSPITAL. CAPACITY 100,000 GALLONS; HEIGHT, TOP 139 FEET.

for the State. There has also been in progress on a day's labor basis, the completion of the earth dam, with a concrete core wall. This structure is now complete and makes an excellent dam, with a storage capacity of about 110,000,000 gallons of water. Some changes in the original plans were necessitated by the inability of the original soil to sustain the weight of earth fill on either side of the core wall. The original location of the pipe line being about on the central lines of the dam was piled thoroughly at the pipe joints in excess of original plans, but even then could not sustain the pressure from above. This plan was abandoned and a tunnel was dug through solid rock for 200 feet and then through earth and boulders for 237 feet. In the solid rock part of the tunnel was erected a solid concrete bulkhead and pipe intake. From here a double line of ten-inch pipe ran through the tunnel to its exit. The earth and boulder line of tunnel was lined with reinforced concrete, making the outlet to the dam one of the most substantial pieces of work in California. The work on this structure under the last appropriation was done by day's labor at a saving over the first work done on it by contract before this department was in existence.

There has been a new floor of steel and concrete with new layout for the Napa Hospital kitchen designed. Nothing has yet been done on this on account of the lack of funds.

STOCKTON STATE HOSPITAL.

There was designed and installed a new heating arrangement for a part of the buildings. This work was done by contract for $5,740. The Department also designed a new plumbing layout for this institution, but it has not yet been started. In these older institutional buildings the plumbing is very poor and deficient. It is of the old type, badly worn and racked, and should be replaced with good, first class fixtures and work. Specifications for the concrete sidewalks were gotten out and the work done by day's labor.

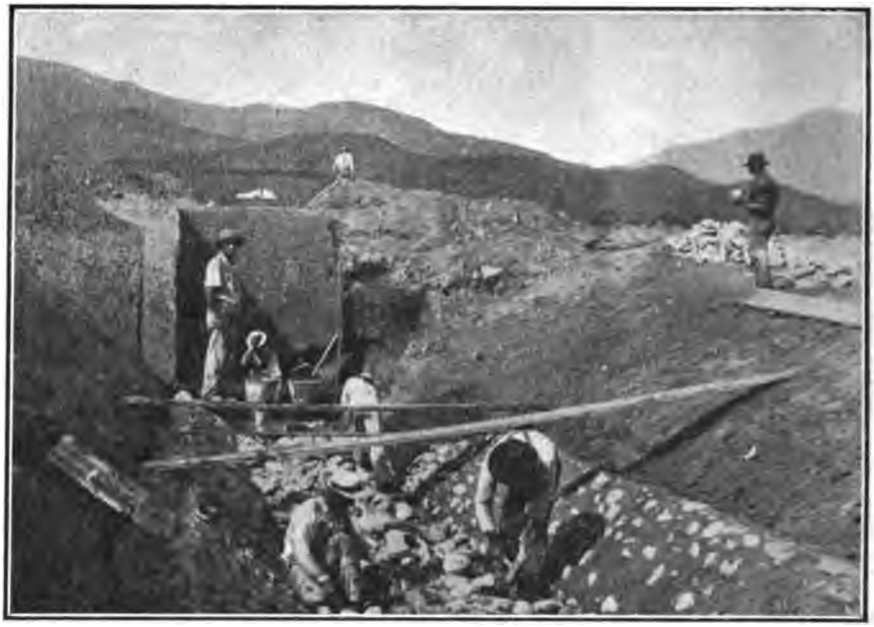
SOUTHERN CALIFORNIA STATE HOSPITAL.

In addition to the receiving building, which the Board of Managers desire to erect by contract, there has been erected and finished a fine dairy barn 269 feet long with concrete foundations and stalls. This structure was contracted for at $10,430, without the painting and stalls, which was done afterward by the institution.

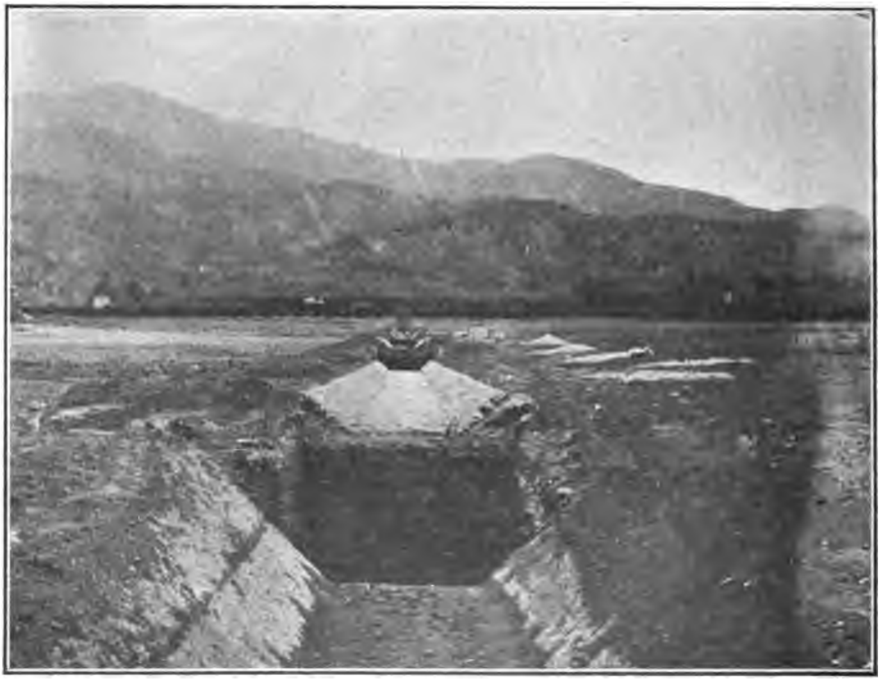
The repairs to roofs have been completed. Our plans called for new trusses and timbers, and a covering of slate to replace the old tin shingle roofs. This improvement was badly needed, as is the roof on the west wing of the building. This part of the main building is very poorly constructed and was cracking lengthwise and apparently falling apart. During 1907 this department advocated, and was instrumental

INSIDE VIEW NAPA STATE HOSPITAL EARTH DAM.

EXTERIOR VIEW, NAPA DAM.



STORM DRAINS, SHOWING WATER FALLS AND WATER CUSHIONS, SOUTHERN CALIFORNIA STATE HOSPITAL.



STORM DRAINS DURING CONSTRUCTION, SOUTHERN CALIFORNIA STATE HOSPITAL.

NEW DORMITORY, CALIFORNIA POLYTECHNIC SCHOOL.

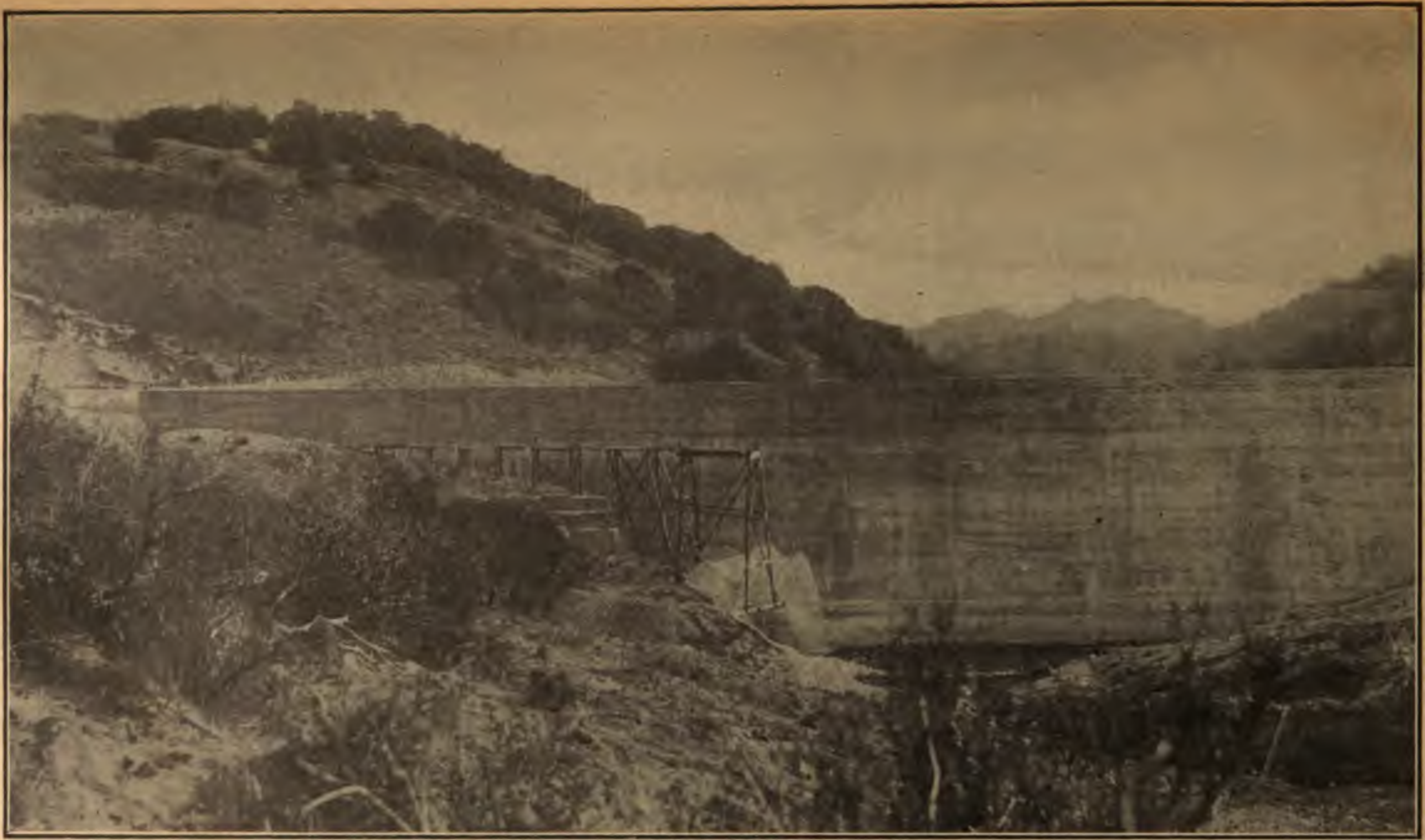
in, having this wing rodded from wall to wall, then with turnbuckles drawn together as nearly as possible by this means. Its foundation is in bad condition, and we were watching the structure for more defects before beginning to replace the tin roof. An appropriation should be made for the purpose of slating this wing, that the old leaking roof may be improved to correspond to the remainder of the building. One important plan laid out for this institution was the storm drains, to avoid the gullying out of the land adjacent to the buildings. The soil in this section of California erodes with the greatest rapidity and ease. No system can be devised that will not require good care and maintenance on account of such soil. The money appropriated by the 1907 legislature was totally insufficient to construct the complete drainage scheme, but a part of it has been satisfactorily completed after much delay in an endeavor to get a fair contract price. Our estimate of a section of the work to be contracted was $14,012; the actual cost to the contractor was $11,593. Under this contract there was constructed 3,300 feet of ten-foot ditches and much grading and filling. A new idea in hydraulic engineering was applied to this work. Water cushions were supplied the ditches to take out the grade and relieve the tendency to wear on the work and material of the ditch. This principle was begun in the State by this Department, and I think will prove very effective in certain classes of work. The construction consists of ditches paved with rocks, with crevices grouted and with waterfalls and water cushions of reinforced concrete. It is estimated the completion of this important work will cost about $13,000, and it is recommended that such an appropriation be made.

SAN LUIS OBISPO POLYTECHNIC SCHOOL.

Considerable work has been accomplished at this school during the past one and one half years. A forge shop, machine shop, and propagation house, all frame buildings, have been completed on the day's labor basis. A creamery building, two cottages for help, and a dormitory building are about completed. These last three structures were let by contract. The two cottages are frame, upon concrete foundations, as is also the creamery building. The dormitory, which will have a capacity of 60 students, is a frame structure with wire lath and plaster, and a concrete foundation. See the table of buildings for the cost, estimate, etc.

VETERANS' HOME.

This institution is made of the very cheapest frame buildings, and naturally must receive considerable maintenance expenditure. The full result of cheap building can be realized here upon a thorough examination of the structures. From now on the State will be put to heavy expense for repairs, which will be interminable, so long as these build-



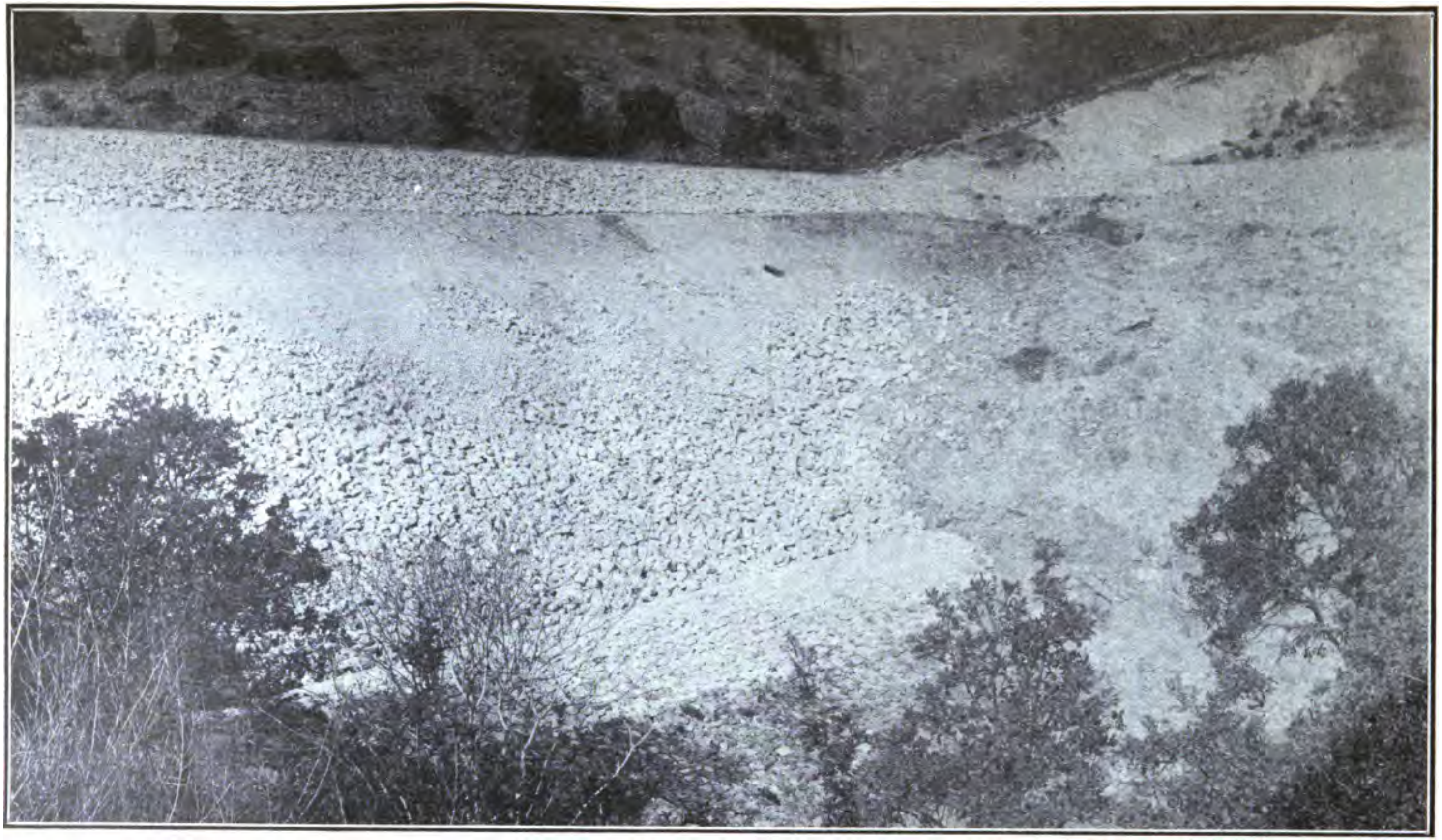
VETERANS' HOME DAM, 50 FEET HIGH, 400 FEET LONG, REINFORCED CONCRETE FACING ONE SLAB.

ings remain in use. If the institution were upon a permanent basis these buildings could well be replaced with permanent work, and be a paying investment to the State. Many repairs are now needed and should be made without further delay—and then greater expense. The work done at the Veterans' Home was all by day's labor. The repairs to roofs was made, but the money was insufficient to paint the shingles as should have been done. In the plumbing, too, a considerable portion of the plumbing fixtures were unused on account of the lack of funds. The appropriation of $5,000 for the commissary building was totally inadequate to meet the desires of the Board of Directors. The appropriation of $5,500 for the septic tank for the sewage disposal plant was too small to permit of the construction of a complete plant, so the equalizer tank and septic tank proper were erected for a daily capacity of 120,000 gallons. The contact beds were left untouched, as was also the fittings for the other two divisions of the plant. The completion of this work should be undertaken at the earliest date possible, and I would therefore recommend for its completion $3,500.

For water supply $24,000 was appropriated. After fully considering the old dam in the hills above the buildings, it was decided to utilize the old fill and face it with reinforced concrete, and drill a tunnel through the lava rock for the outlet. The concrete slab facing is 12 inches thick at the bottom, is set in a trench in the lava rock, then decreases in thickness until at the top it is 6 inches thick. This single slab is 56 feet high and about 400 feet long. The tunnel is 130 feet long and contains a solid bulkhead of concrete and a double pipe line. The idea of such a facing of concrete has, to my knowledge, never before been attempted in this character of construction. The height of the old structure was increased 10 feet, a new spillway was built, and the work was as substantially done as any construction the State has undertaken. Its capacity is 22,000,000 gallons, and the cost of the work was $22,439.17.

STATE FAIR BUILDINGS.

Since the Department's existence there has been constructed under its charge a poultry building and stock barn on the grounds of the Agricultural Society, near Oak Park, Sacramento County. These two wooden buildings were some of the first constructed by this Department, and your attention is directed to their cost in the table of costs of buildings. There has also been designed an agricultural pavilion and a manufacturers' pavilion for the same grounds, but the appropriation of $50,000 is insufficient to build both buildings. They will cost about $66,000, and the balance of this cost should be appropriated at this session of the legislature. While making these designs we sketched a layout for a complete exposition ground to fit the surroundings, with a view of working to it. The present grand stand should be torn down and a



VETERANS' HOME DAM, SHOWING BACK FILL OF BROKEN ROCK.

new one erected. It is an unsightly building and has a great excess of bracing, unreasonably placed for its strength. I specially recommend its removal, and a more pleasing stand built.

SAN DIEGO NORMAL SCHOOL.

The appropriation of $40,000 for the training school building was inadequate for the necessary room the Board of Trustees wanted provided. For this reason the hope of building this structure was abandoned until some legislative action could be taken in an endeavor to increase the appropriation to $62,000. This new building should harmonize in architecture with the other buildings, and should be built of either reinforced brick or reinforced concrete.

OAKLAND HOME FOR ADULT BLIND.

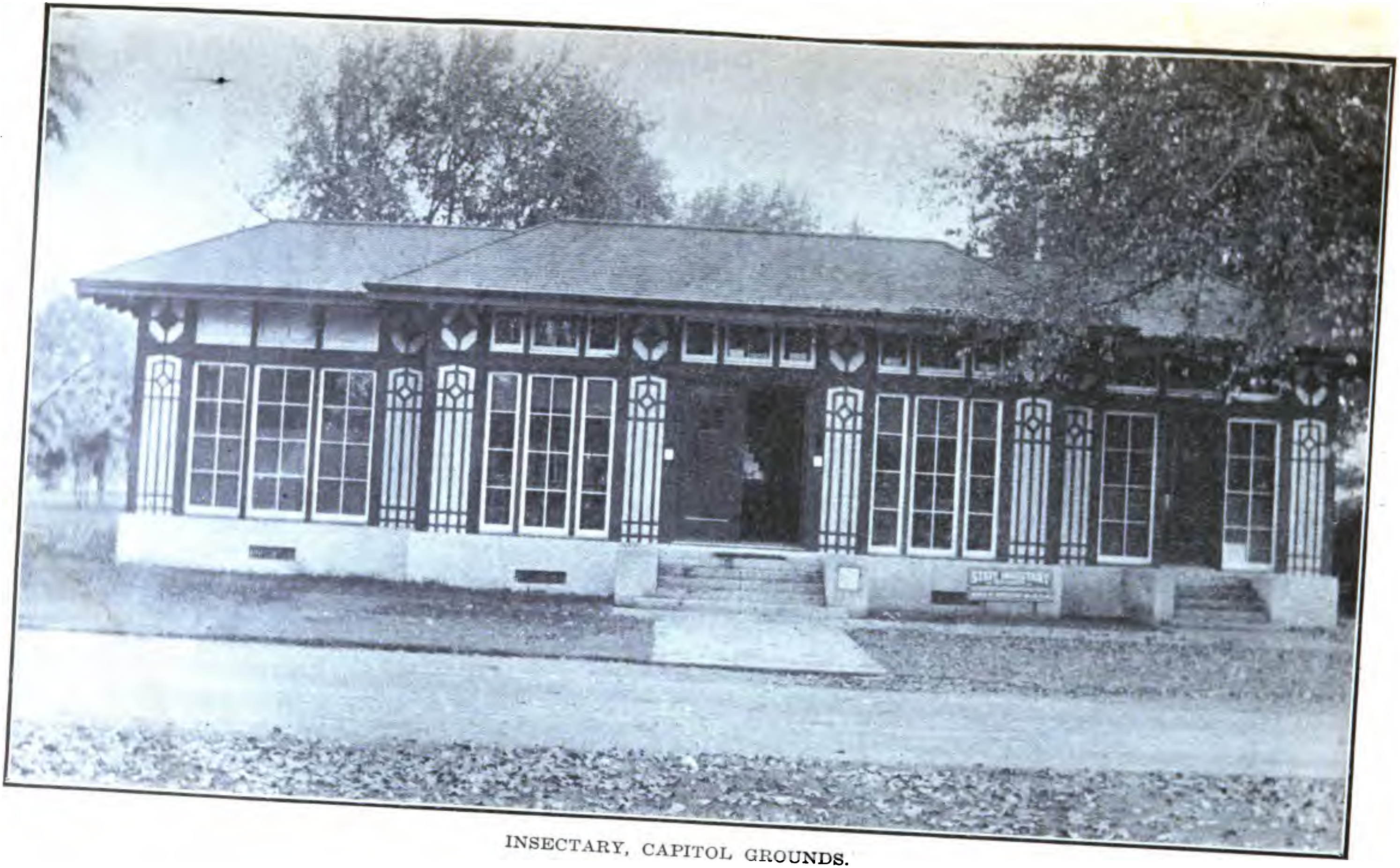
The dormitory building made possible by the appropriation during 1907 is well under way, practically all the concrete is poured, and the framing for the roof trusses is begun. This building is under contract for approximately $46,000, and will be the first substantial structure on the grounds of this institution. It is two stories in height, with a partial basement, and of reinforced concrete walls and floors. Undoubtedly when finished it will add greatly to the general appearance of the grounds. There should be an appropriation for the construction of a concrete sidewalk on Thirty-sixth street, Oakland, and for walks in the grounds of about $3,500.

STATE PRINTING BUILDING.

The old residential building used as a printing office and the storerooms used in connection therewith detracts from the beauties of the Capitol Park. During last year we designed some strengthening timbers and rods for the main building, as it was in a dangerous condition for people to work in. This work was done with the intention of bracing the building temporarily, and cost about $1,100. There should be some provision made for a new printing structure, for the present old shell can not last but a few years without heavy expense of repair, and then to no advantage.

INSECTARY.

On the Capitol grounds we erected for the Horticultural Commissioner a building for the propagation of insects. The location of this structure made it necessary to have it sufficiently decorative and suitable so that it would not mar the grounds. It therefore was designed with this in view. Both the design and construction were difficult because it closely resembles cabinetmaker's work, there being so much small detail. A photograph is presented herewith giving a splendid idea of it.



INSECTARY, CAPITOL GROUNDS.

EXPOSITION BUILDING, SEATTLE.

One of the most decorative buildings under construction on the Alaska-Yukon-Pacific Fair grounds at Seattle is the California Building. It is also among the largest there, measuring 232 feet in length and equal to two stories in height. The main body of the building is 138 feet by 138 feet, with wings on either side. This structure, which is nearing completion, is being done by day's labor, and I might add at a cost far below our estimate and at a vast saving to the State. The cost will be about $35,000, or $10,000 below the estimate made for it. The building has been almost entirely under the charge of this department through our superintendent of construction, Mr. B. Thomas.

FERRY BUILDING, SAN FRANCISCO.

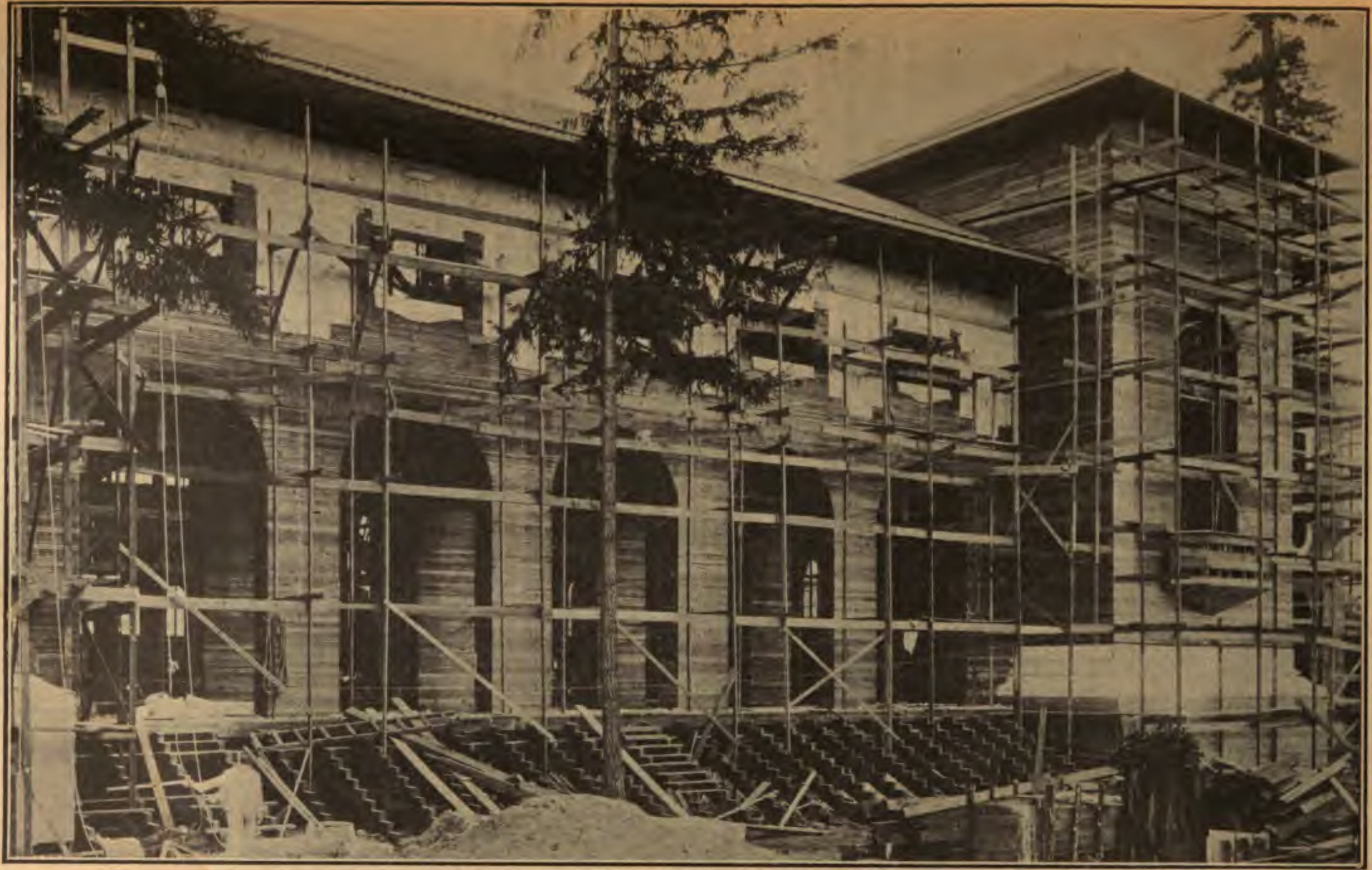
The alteration of the south wing of the Ferry Building, where the ticket offices are, the design of a candy booth in the front of the building, the design for newstands and ticket booths, a chief wharfinger's office, and alterations to the north wing of the building is the architectural work done by the Department. All the work mentioned herewith has added greatly to the appearance of the building, and I believe will give entire satisfaction.

SAN FRANCISCO OFFICE BUILDING.

This structure is now being designed by the Department and from present indications the plans will be ready for bidding about May 1, 1909. This building will be what is known as a class A structure, or steel frame, with curtain walls of stone, brick, and terra cotta. The present idea is to have a monumental office building designed to meet the demands of the State officials who will occupy it. The lot of land has already been purchased on the corner of Polk and Fulton streets.

SAN QUENTIN AND FOLSOM PRISONS.

At Folsom we now have under construction the wall, twenty feet high, enclosing the prison proper. At the entrance this will have a massive double gate, which was designed by the Department. The wall and gate are of cut ashlar granite, which will need trimming or spalling off after erection. We have also opened a new quarry of granite to meet the increased demand for stone, constructed a runway to obtain goods at the commissary from the track near the canal, erected, by contract, for $6,300 a new electric generator, panel board arc lamps and appurtenances, and are cutting out the foundation for a new 500 single cell building. Its location comes in a solid granite formation, the dip of which towards the American River makes the west end deep in decomposed granite to get an even footing. The east end of this foundation is solid granite. The design of this building is complete and gives many



CALIFORNIA BUILDING, SEATTLE. ALASKA-YUKON-PACIFIC FAIR, DURING CONSTRUCTION, NOVEMBER 19, 1908.

new features, such as interior guard gallery, utility corridor, cell blocks of reinforced concrete, one man cells, plumbing fixtures in each cell, and complete ventilation. The outer shell or building proper is to be built of cut ashlar granite of a neat, plain, but heavy design. Outside of the wall is now being erected the hospital for the criminal insane. Some changes have been made in the original plans by this Department, but the main structural part of the building is cut ashlar granite. The work done on all this construction is by prisoners, and in the case of the hospital for the criminal insane, the progress has been hindered by lack of cut stone. The completion must await an additional appropriation, as the funds are now about exhausted.

At San Quentin Prison the cutting away of South Hill began before the organization of the department, but was continued and finished by us about September 15, 1908. Upon becoming the official head of the Department of Engineering, it came to my attention that there was employed at the prisons an engineering department to carry on their work at an expense of $700 per month. I therefore presented the matter to the Board of Prison Directors, advocating the reduction of the force, retaining one man at $200 per month under the head department to oversee the work. This request was immediately favored, and the reduction in expense made. Now there is employed a civil engineer for prison work at $125 per month. The plans for an 800 single cell building, including all the features of the Folsom Prison new cell building, a kitchen building, a dining-room building, and a general block plan for an eventual whole new prison, is being designed to now partially supplant the antiquated structures and finally all of them. All buildings will be massive reinforced concrete, located principally on the site of South Hill. The structures are so arranged that their outer walls will serve prison wall purposes also. In the dining-room an interior guards' gallery, with entrance and exit from the outside only, will be a vast improvement over present methods used in the dining-room. This gallery is about nineteen feet above the floor level and can not be reached from inside the building.

The contracts for materials for the 800 cell building, the kitchen and dining-room, were let by the Prison Board and excellent prices were obtained, saving the State much money. The excavation for the footings on the 800 cell building is now proceeding, but before we could receive any of the heavy building materials we were compelled to build a new wharf at the prison and extend the present one about 140 feet to the south. It is now completed, and the shipment of materials may now begin. As the prisoners are to do all work they possibly can on the new construction, the plans have been far enough advanced for two months past to not hinder or tie up the work.

WORK AT SUTTER'S FORT.

The Department made plans, specifications, and estimates for improving the grounds at Sutter's Fort under an appropriation for the work of $1,500. Our estimate for the work was $1,224.38, but when proposals on the work were sought and received, no bid came within the appropriation, and this Department advised the rejection of all bids and that the Board of Trustees make informal agreements on our estimated basis, which was done, thus bringing the cost of the work practically to our figures. The roof and floor of the old distillery building at the Fort were estimated. The floor area contained 1,007 square feet, and was contracted at fifteen cents (15) per square foot. The old roof tiles were removed and felt roofing was placed, and then the old tile reset upon this.

ARCHITECTURAL PLANS.

In looking over the plans heretofore furnished the State for its building work, the small number of drawings attracted my attention. At the outset, I demanded complete plans for the structures we were to have charge of, and therefore we have made drawings consistent with the work to be done. Where the State had been furnished, say twelve sheets of plans heretofore for a structure, this Department has furnished about twenty-five sheets, and, in addition, the full size detail drawings. The completeness of our building plans may be seen upon looking over our files and particularly noting what has been done. For instance, we made one hundred and twenty-nine sheets of drawings for the San Jose Normal School building, and this was even relatively a smaller number of sheets than on some of our other plans. Building plans as furnished the State before the inauguration of the Department can be gotten out for from forty to fifty per cent of the cost of the plans we now furnish, and in some cases for less. Complete plans reduce the extras a contractor has coming to him on a piece of work. The plans now made by the State have reduced the real extras to a minimum. For example, the extras on the $507,000 worth of contract building work at Agnews State Hospital will not exceed $700. This, in making plans, is very important; but is not so important as to avoid skeleton plans that allow the contractor to place his figure high for contingencies that might arise. It is the belief that when the contractors know what is to be done on a building they can figure more closely, and with a far better understanding of the work. In the matter of getting up this work for the State, the Department has proceeded along the most economical lines. The usual charge for plans is five per cent of the cost of the new work and seven and a half per cent of the cost of the alteration work. I have no intention to mislead and say this charge is too high, for it is not; but what I do wish to impress upon the reader is the quality, character, size, and cost of the building plans made by the Department. In numerous instances plans have been changed four or five times after adoption by the authority at the institution, notably the dairy barn and receiving building at the Southern California Hospital, six building plans at the Agnews Hospital were finished, then abandoned, complete new plans being made, and the creamery building at the Polytechnic School. Then again, a number of the plans have been changed twice, such as the administration building at the Feeble-Minded Home, Eldridge, California, and the receiving building at Mendocino State Hospital. Again, where there is much detail on cheap or small buildings, such as the Seattle Fair Building, the Ferry Building candy booth, and the Insectary, the plans are exceptionally expensive, requiring much more work relatively than larger and more costly buildings. For the percentage of cost of the plans to the State under the Department, the actual cost of those buildings already erected is taken. On buildings under construction or contemplated, the contract price or our estimates are given. It will be noted by reference to a following table the estimates agree very closely in general with costs of structures. In many instances, where buildings are constructed by day's labor, such as the receiving buildings mentioned before, prison building, or buildings at the reform schools, as at the Preston School of Industry, the patients, prisoners, or students do the greater part of the work. We have estimated the cost of the buildings upon a day's labor, not a contract, basis. Summing up the cost of all the new building work, we have a value of $2,769,382, and the percentage of cost of plans was 2.83 per cent. The alteration work amounted to $68,187, and the average percentage of cost was 2.3 per cent. This general percentage of cost includes the salary of the architect and the one statutory draftsman in order to get a fair comparison. The saving on a 5 per cent basis for new work and 7½ per cent on alteration was $62.310. We did work of design on a bridge at the foot of Market street, San Francisco, commissary building at the Veterans' Home, a log cabin for the Big Basin Park, changes in plans for the building for the criminal insane at Folsom, Warden's residence at Folsom, a dormitory at the Feeble-Minded Home, Cohn cottage, and Girls' cottage at the same institution. This drafting and designing was not complete in any of the structures—sometimes only details, and again additional plans to originals furnished by others. Aside from these minor drawings upon which we can not figure any percentage, the total cost of plans, specifications, bills of materials, estimates, and all details, has been $71.307.10.

It is earnestly believed that with better facilities and more room for working, the cost of plans may yet be reduced materially.

The building work of the State should be placed further into the hands of the Department that building materials may be bought in purchasing agent for the State in these matters at the hospitals is the steward, and at the other institutions some designated person. In large quantities, and thereby effect a great saving. As it is now, the numerous instances the people who have done this buying have stated they were not acquainted with this class of materials and the prices therefor. We have always endeavored to assist them and obtain figures for the needs of the building, but were handicapped by not having the authority to complete the transaction.

The great necessity for a good reliable buyer for this Department is plainly seen by looking at the following deal made by myself and sanctioned by the Advisory Board. During the fall of 1907 I began obtaining prices on cement, and finally after receiving bids or proposals about three times made a contract with the Western Building Material Company, September 21, 1907, for cement f. o. b. factory at $1.27 per barrel. We can receive on this deal 100,000 barrels, and yet may possibly need more before the contract terminates, May 21, 1909.

The reader may best compare the cost here presented to the price heretofore paid by the State by noting that during the life of this contract a carload of cement was ordered from another concern, and the price was $2.25 per barrel f. o. b. factory. Now, say the price was $2.10 per barrel f. o. b. factory, the State saved alone on this one transaction $83,000. This is not unreasonable, for I have ascertained that the State ordinarily pays a top price without getting the advantage of close figures. With a good, reliable business man as a buyer, undoubtedly the State could make a vast saving along the line above mentioned. The saving on this cement alone more than paid for all the expense of the architectural division of the office in its great amount of work.

Before leaving the subject of buildings, I desire to draw attention to one very difficult problem. The lack of a proper block plan for each institution. There should be a complete survey made of the grounds, giving the contours, sewer lines, all pipe lines, natural objects, buildings, water supply, etc., and then a complete plan should be outlined for the building arrangement. If such a scheme were followed, we could locate the buildings for future needs, and also arrange to have the central power plant economically situated. As it is now, the institutions are yearly receiving additions without proper attention to a comprehensive scheme of location. We have made such a survey and layout for the Agnews State Hospital and the San Jose Normal School in connection with their whole new structures, but the other institutions are badly in need of this work. I believe there should be an appropriation for the purpose of making such survey and block plan of buildings. It would certainly reward the State tenfold in a very few years, for as it now is, if one desires to find an underground pipe sometimes he will spend two or three days. Again, with such a plan, heating, gas, water pipes, etc., may be located at a minimum of cost. It is suggested that an appropriation of $5,000 be made for this purpose.

CALIFORNIA REDWOOD PARK.

There was designed a log cabin for this park, but the lack of funds has delayed its building. During October this year, Mr. P. M. Norboe, assistant in the department, went to the Big Basin Grove and spent four days in making a survey for the contemplated sewage disposal plant and water supply. I herewith append the report on the subject:

October 17, 1908.

MR. N. ELLERY, *State Engineer, Sacramento, Cal.*

DEAR SIR: In compliance with your verbal instructions made at the request of Mr. G. B. Lull, State Forester, I visited the California Redwood Park, near Santa Cruz, and investigated the feasibility of installing water supply and sewage disposal systems for the main camp.

That portion of the Park which attracts most visitors is a small valley in the middle of the "Big Basin," at the junction of the East Fork of Waddell Creek with Bloom's Creek. The floor of the valley is slightly rolling, covered with a heavy growth of virgin forest and dense undergrowth. The administration headquarters and main camping ground, known as Governor's Camp, is situated in the north arm of the valley, along Waddell Creek and at the terminus of the road from Boulder Creek. From this point trails radiate in several directions to different points of interest, but no wagon roads as yet have been constructed.

About ten (10) acres of the valley have been partly cleared of underbrush, and it is here that the administration buildings, boarding and lodging houses and camps are established.

The number of inhabitants, campers, and visitors have seldom exceeded two hundred (200) in one day, but as the Park becomes better known and its beauties appreciated, the number of visitors and of campers will be greatly increased, so that facilities should be provided for about one thousand (1,000) people.

The only water supply now available is Waddell Creek, flowing along one side of the camp ground. The only means of disposing of sewage and refuse is by depositing on the surface of the ground or in pits. In either case it finally reaches the creek and in a short time will become a menace to the health of all using the water of the creek.

Water Supply.—Water can be brought to the grounds in pipes, under pressure, sufficient for several thousand people, either from Bloom's Creek, Union Mill Creek, Sempervirens Creek, or Maddock Creek, or all combined if need be. All but the last named, however, have their water sheds on private lands used for grazing, sawmills, shake and post makers camps, etc., so that the water is subject to more or less pollution.

The last named, Maddock Creek, has its source removed from accessible timber to tempt the lumberman, and with but little grazing land. At a distance of less than six thousand (6,000) feet from the camp, the creek is at an elevation of 104 feet above the bed of Waddell Creek at Governor's Camp. Water may be piped from here and delivered into tanks on the hillside above the camp at sufficient elevation to give ample pressure for fire protection to the buildings.

At the time of my visit, October 9th, I measured the water flowing in Maddock Creek and found it to be eighteen (18) gallons per minute, equivalent to 25,920 gallons in twenty-four (24) hours, and the creek was lower than has been known in twenty-five (25) years, so that it seems to be safe to estimate this source as sure to provide enough water at all times for over a thousand people at the camp. Should the population be enough greater to require all the supply for domestic use, then by the expenditure of say $150, a hydraulic ram can be installed in Waddell Creek at the camp which will supply the grounds for sprinkling and watering stock.

Sewage Disposal.—As above stated the methods of disposing of sewage matter now in practice is to deposit it in pits or on the surface of the ground. Much excreta is deposited on the ground in secluded spots for the reason that there are no public toilets. Camp slops and refuse are thrown on the ground. As the population increases these practices will become unbearable nuisances as well as menaces to health, even when the source of water supply is removed beyond chance for contamination.

To provide a means of proper disposal of the camp sewage there should be a number of automatic flushing range toilets and urinals placed at convenient and in conspicuous points above the grounds. These to discharge through sewer pipes into a trunk sewer traversing the grounds along near the creek bank, and terminating in a septic tank situated far enough so that any slight odor arising therefrom shall not reach the camp. The effluent from the tank, after undergoing the cleansing septic action, may be discharged into the creek without harm.

I submit a plat of the portion of the park, embracing Governor's Camp and vicinity, also a sketch showing a tentative plan for water supply and sewage disposal plants to cost about $5,000.

I desire to acknowledge my indebtedness to Senator S. H. Rambo, warden, and Mr. J. F. Creed, foreman, for many courtesies and much assistance in my investigations.

Respectfully,

P. M. NORBOE,
Assistant State Engineer.

TABLE No. 1.

Cost of Building Plans, Giving Cost or Estimate and Plan Percentage to November 28, 1908.

Agnews State Hospital Building.

	Cost Price or Estimate.	Cost of Plans.	Operating Expense.	Plans Percentage.	Remarks.
Two quiet and medium	$136,102	$1,741 29	$401 50	1.5	
Assembly hall	100,000	2,595 33	171 30	2.7	2 designs
Two nurses' homes	60,000	651 37	130 98	1.3	
Treatment Building and tower	61.000	2,924 43	220 34	4.8	2 designs
Two receiving buildings	179,313	3,065 52	487 30	1.9	
One power plant	105,000	1,141 40	347 95	1.4	
Superintendent's residence	25,000	2,205 83	238 34	9.7	2 designs with changes
Two demented buildings	91,700	1,731 29	245 11	2.1	
Two convalescent buildings	60,000	1,478 37	117 60	2 6	
Two workers buildings	125,000	2,737 33	209 12	2.3	
Block plan		270 91			
Two infirm buildings	57,788	725 90	306 02	1.7	
One kitchen building	39,232	1,179 28	133 86	3.3	
Two disturbed and violent buildings	85,886	2,446 99	555 88	3.5	2 designs
One administration building	56,000	1,994 64	198 92	3.9	2 designs
One dining hall	45,000	1,930 99		4.3	
One commissary building	17,752	590 39		3 3	
One bakery building	20,000	661 43		3.3	
Laundry building	1,500	73 30		4.9	
Connecting passage	3 000	47 90		1.6	
General drawing		71 95			
Perspective		71 00			
Typical details		4 34			
Extra design		959 87			
Totals	$1,269,273	$31,418 62	$3,650 17		

Estimate $1,300,000. Whole institution 2.6%

TABLE No. 2.

Cost of Building Plans, Giving Cost or Estimate and Plan Percentage to November 28, 1908.

BUILDING.	Cost Price or Estimate.	Cost of Plans.	Operating Expenses.	Percentage of Plans.	Remarks.
Stockton receiving building	$81,000 00	$2,301 99	$468 09	3.4	
Stockton cow barn	6,000 00	150 18		2.5	
Male ward, heating	5,750 00	71 41		1.2	
Plumbing repairs	7,500 00	30 68		0.4	
Home for Feeble-Minded.					
Administration building	70,000 00	2,362 10	456 36	4.0	
Dairy barn	5,000 00	170 05	52 94	4.4	
Manor house	15,000 00	518 81	40 32	3.7	
Nursery	2,000 00	73 39		3.6	
Southern California Hospital.					
Receiving building	55,000 00	1,493 63	272 19	3.2	Changed four times.
Repairs to roofs	12,000 00	286 84	39 56	2.7	Alteration.
Dairy barn	11,000 00	636 71	152 86	7.1	Changed four times.
Folsom Prison.					
Cell building	475,000 00	2,308 14	196 55	0.5	
Double gate and tower	40,000 00	771 59	191 96	2.4	
California Polytechnic School.					
Dormitory	21,000 00	674 19	174 51	4.0	
Cottages	5,000 00	176 81	27 68	4.0	Three complete designs.
Creamery	10,000 00	509 47	115 05	6.2	Changed three times.
Propagation house	1,500 00	57 84		3.8	
Machine shop	5,000 00	176 53		3.5	
Napa State Hospital.					
Receiving building	91,000 00	2,196 72	97 58	2.5	
Detached cottages	24,000 00	715 65		2.9	
Kitchen floor	1,500 00	41 56		2.7	Alteration.
Veterans' Home.					
Repairs to building	8,000 00	130 73		1.6	Alteration.
Plumbing repairs	2,500 00	39 13		1.6	Alteration.

Mendocino State Hospital.					
Receiving building	43,000 00	1,060 05	218 69	2.9	Revised two times.
State Agricultural Society.					
Stock building	2,190 00				
Poultry building	4,480 00	210 76		2.7	
Lavatories	896 00				
Agricultural pavilion	40,000 00	961 57	42 72	2.5	
Manufacturers' pavilion	25,000 00	782 80	111 01	3.5	
Seattle building	40,000 00	1,563 30	250 35	4.5	Very decorative.
Insectary	7,466 50	379 37	93 42	6.3	Nearly cabinetwork.
San Jose Normal School	330,000 00	9,248 75	569 59	2.9	Estimate not yet made. Least is given.
San Diego Normal School	*40,000 00	*52 72	*14 92		Sketched and details only.
Ferry Building, San Francisco.					
News and fruit stand	3,950 00	194 00	3 24	5.0	Alteration.
South wing	7,300 00	280 04		3.8	Alteration.
North wing	23,623 00	365 10		1.5	Alteration.
Post office	1,972 00	86 64		4.3	Alteration.
Wharfinger's office	4,842 00	85 76		1.7	Alteration.
Blind Home, Oakland.					
Dormitory	46,000 00	1,406 13	124 54	3.3	
San Francisco Normal School building	4,828 00	96 06		2.0	Alteration.
Preston School of Industry.					
Repairs to buildings	2,500 00	65 44		2.6	Alterations.
San Quentin Prison.					
Cell building and layout	*2,000,000 00	*1,439 20	*245 15		Not complete.
State office building, San Francisco	*400,000 00	*169 63	*41 39		Not complete.
Total	$1,469,782 00	$31,008 53	$3,513 68	2.35	New work.
Total	73,015 00	1,673 30	42 80	2.3	Alterations.

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*Not used.

TABLE No. 3.

Buildings Constructed or Under Construction by Contract.

Name of Building.	Contractor.	Estimated Cost.	Contract Prices.	Date of Contract.	Kind of Building.
Agnews State Hospital.					
Two infirm	Morrison Bros.	$69,036 00	$57,888 00	April 28, '08	Reinforced concrete.
Two receiving	F. O. Engstrum Co.	212,000 00	176,038 00	June 17, '08	Reinforced concrete.
One demented	F. O. Engstrum Co.	50,560 00	45,850 00	June 17, '08	Reinforced concrete.
Two quiet and medium	F. O. Engstrum Co.	137,620 00	136,102 00	Aug. 31, '08	Reinforced concrete.
Two disturbed and violent	Rickon, Ehrhart Co.	86,000 00	85,860 00	Sept. 23, '08	Reinforced concrete.
California Polytechnic School.					
Two cottages	J. Maino & Sons	$3,570 00	$3,848 00	May 14, '08	*Frame.
Creamery	F. O. Engstrum Co.	10,000 00	9,980 00	June 25, '08	*Frame, lath and plaster.
Dormitory	F. O. Engstrum Co.	22,152 00	20,765 00	June 25, '08	Frame, lath and plaster.
Southern California State Hospital.					
Dairy barn	J. C. Beer	$15,000 00	$10,430 00	July 17, '08	*Frame, Painting and stalls excluded.
Stockton State Hospital.					
Heating	J. G. Sutton Co.		$5,740 00	May 29, '08	
Industrial Home For Adult Blind.					
Dormitory	Rickon, Ehrhart Co. and San Francisco Rebuilding Co.	$47,000 00	$44,630 00	Aug. 6, '08	Reinforced concrete.
Ferry Building, San Francisco.					
Alteration south wing	Walsh & McLaughlin	$9,000 00	$7,300 00*		Glass, marble, and steel.
Alteration north wing	Jordan & Co.	21,000 00	23,623 00		Glass, marble, and steel.
Alteration news stand and fruit stand		5,000 00	3,950 00		Glass, marble, and steel.
Wharfinger's office		2,846 89	3,489 00		Frame.
Post office alterations		1,400 00	1,248 00		

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* These have been completed.

TABLE No. 4.

Buildings Constructed or Under Construction by Day's Labor.

Agnews State Hospital.

Name of Building.	Estimate of Cost.	Cost When Finished.	Additional Work.	Kind of Building.
Kitchen building	$39,232 00	Nearly finished		Reinforced brick and concrete roof.
Bakery building	18,000 00	$19,774 95	Ovens extra $2,733 00	Reinforced brick and concrete roof.
Commissary building	18,000 00	17,752 11	Corridor extra $2,000 00	Reinforced brick and concrete roof.
Demented building	50,560 00	Nearly finished		Reinforced concrete.
Dining building	45,000 00	Nearly finished		Reinforced concrete.
Agricultural Society Buildings.				
Stock building	$2,710 00	$2,190 27		Frame, concrete piers.
Poultry building	4,200 00	4,480 00		Frame, concrete piers.
Lavatories building	715 00	896 00	Also bored ground for gravel bed	Frame.
Seattle building	40,000 00	Will be below estimate. Nearly finished		Frame.
Insectary	8,500 00	7,466 50	Breeding case left out and cheaper heating used.	Frame, concrete foundation.
California Polytechnic School.				
Propagation house	$1,500 00	$1,441 04		Frame, concrete foundation.
Machine shop	5,000 00	5,723 00		Frame, concrete foundation.
Southern California State Hospital.				
Roofing	$12,000 00	$11,500 00		Replacing old roof with slate.
Napa State Hospital.				
Detached cottages	$24,000 00	Nearly complete.	Patient labor.	Plain one-story brick.
Receiving building	91,000 00*	⅓ done, mostly	patient labor.	Reinforced concrete.

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* Estimate on day labor basis without institutional help. Prison work not given; entirely done by prisoners.

TABLE No. 4—Continued.

Name of Building.	Estimate of Cost.	Cost When Finished.	Additional Work.	Kind of Building.
		Feeble-Minded Home.		
Administration building	$70,000 00	Half finished		Reinforced brick, three-stories.
Two epileptic cottages	24,000 00	$20,000 00		Frame, concrete foundation.
One barn	5,000 00	Nearly finished		Frame, concrete foundation.
One manor house	15,000 00			Frame, concrete foundation.
		Mendocino State Hospital.		
Receiving building	$43,000 00*	¼ done, mostly	patient labor.	Reinforced concrete.
		Veterans' Home.		
Repairs to buildings	$8,000 00	All used		Roofs, bracing, floors, etc., repairs.
Repairs to plumbing	2,500 00	All used		
		San Francisco Normal School.		
Changes and repairs to old building	$5,000 00	$4,828 00		Changes principally.
		State Printing Office.		
Repairs for strengthening	$1,050 00	$1,182 23		Rodding and placing timbers in old building.
		Stockton State Hospital.		
Receiving building	$81,000 00*	½ done, mostly	patient labor.	Reinforced concrete.
Cow barn	6,000 00*	$3,563 92	Mostly patient labor.	Frame, concrete foundation.

*Estimate on day labor basis without institutional help. Prison work not given; entirely done by prisoners.

TABLE No. 5.

General Engineering Work at Public Institutions.

	Estimated Cost.	Contract Price.	Actual Cost.
Septic tanks, Southern California Hospital	$6,750 00	$6,376 84	
Storm water drains, Southern California Hospital	14,012 00	13,746 29	*$11,593 00
Electric installation, Folsom State Prison		6,341 00	
Trestle to quarry, Folsom State Prison			1,677 35
Oil tanks, Mendocino State Hospital	3,087 00	3,100 00	*2,818 00
Water tower, Mendocino State Hospital	5,626 00	8,000 00	*5,622 43
Landscape improvement, Sutters Fort			1,224 38
Septic tanks, Soldiers' Home, Yountville			6,105 33
Repairs to dam, Soldiers' Home, Yountville			22,439 17
Cement sidewalks, Stockton State Hospital			6.146 27
Steel stack, Agnews State Hospital	1,777 00	2,536 00	*2,115 00
Oil tanks, Agnews State Hospital	1,534 00	2,800 00	*1,736 12
Concrete stack (not constructed) Agnews State Hospital	1,079 00		
Asphalt-macadam pavement, San Diego Normal School		3,000 00	*2,426 87
Wrecking buildings, San Jose Normal School		3,000 00	*3,000 00

*These costs are the actual costs to the contractor, exclusive of profits.

The system of daily reports, which are sent in from every piece of construction work, has now been in use sufficiently long to show the value of this scheme. From this on we will have our estimating work on a basis that will prove very efficient. I herewith present some information in regard to the plan. Summarized, the daily building report contains the following subdivisions, and a weekly time card for each worker. From these time sheets, bills, and reports the work is segregated and ultimately unit prices obtained. Following the résumé of the daily report is a summary giving unit costs on the two Agnews State Hospital buildings, the bakery and commissary buildings:

DAILY BUILDING REPORT.

Class of work—

1. General.
2. Preliminary.
3. Temporary:
   - *a.* Sheds and scaffold,
   - *b.* Plant and tools.
4. Earth Work:
   - *a.* Excavating,
   - *b.* Fill,
   - *c.* Grading.
5. Masonry:
   - *a.* Brick,
   - *b.* Stone,
   - *c.* T. C. tile partitions.
6. Forms.
7. Concrete.
8. Reinforcing:
   - *a.* Bars,
   - *b.* Fabric.
9. Structural steel.
10. Sheet metal.
11. Ornamental iron.
12. Carpentry:
    - *a.* Rough.
    - *b.* Doors and windows placed and finished—complete,
    - *c.* Millwork, outside and inside.
13. Furring and lathing:
    - *a.* Metal,
    - *b.* Wood.
14. Plastering:
    - *a.* Exterior,
    - *b.* Interior.
    - *c.* Ornamental.
15. Painting and waterproofing.
16. Underground pipe work.
17. Roofing:
    - *a.* Tile, slate, shingles,
    - *b.* Metal,
    - *c.* Asphalt.
18. Flooring:
    - *a.* Cement,
    - *b.* Wood,
    - *c.* Patent.
19. Electric.
20. Heating and ventilating.
21. Plumbing.
22. Skylights.
23. Marble.
24. Tile and mosaic.
25. Cold storage.
26. Elevators.
27. Machinery.

UNIT COST FROM SEGREGATION SHEETS MADE FROM DAILY REPORTS.

Agnews Bakery Building.

Unit cost of excavation per cubic yard	$0 82½
Unit cost of forms complete per yard of concrete	4 59
Unit cost of form labor per yard of concrete	3 08
Unit cost of form material per yard of concrete	1 51
Unit cost of concrete complete per yard	18 59
Unit cost of reinforcing steel per yard of concrete	3 01
Unit cost of reinforcing steel labor per yard of concrete	89
Unit cost of crushed rock per yard of concrete	1 22
Unit cost of sand per yard of concrete	44
Unit cost of gravel per yard of concrete	87
Unit cost of cement per yard of concrete	3 49
Unit cost of concrete workers per yard of concrete	3 45
Unit cost of inspectors and timekeeper per yard of concrete	63
Unit cost of rock per yard	1 60
Unit cost of sand per yard	1 84
Unit cost of gravel per yard	1 37
Unit cost of form lumber per M	13 32
Unit cost of labor on reinforcing steel per ton	16 21
Unit cost of structural steel (roof) "contract"	1,268 66
Unit cost of structural steel (roof) labor	86 36
Unit cost of asphalt roofing per square yard	58¾
Unit cost of brick per M (old)	2 00
Unit cost of brick per M (new)	14 55
Unit cost of sand per yard	1 84
Unit cost of lime per barrel	1 84
Unit cost of teams and labor per M brick	49
Unit cost of sand per M brick	1 11
Unit cost of lime per M brick	45
Unit cost of cement per M brick	2 35
Unit cost of material for steel reinforcing per M brick	43
Unit cost of miscellaneous steel per M brick	1 59
Unit cost of labor on steel	87
Unit cost of labor on steel per ton	50 20
Unit cost of scaffolding per M brick	26
Unit cost of masons per M brick	8 68
Unit cost of masons' tenders per M brick	3 07
Unit cost of brick work complete per M	25 17
Unit cost of asphalt roofing per square yard	58¾
Unit cost of material for metal lath and furring per yard	43
Unit cost of labor complete metal lath and furring per yard	33
Unit cost of steel workers' metal lath and furring per yard	23
Unit cost of furring metal lath and furring per yard	10
Unit cost of metal lath and furring complete per yard	76
Unit cost of painting material per square yard	087
Unit cost of painting labor per square yard	57
Unit cost of painting complete per square yard	65.7
Unit cost of outside plastering complete per yard	1 57½
Unit cost of cement per yard of plaster	34
Unit cost of sand per yard of plaster	13
Unit cost of lime per yard of plaster	04
Unit cost of plasterers per yard of plaster	62½
Unit cost of plasterers' tenders per yard of plaster	33
Unit cost of scaffolding per yard of plaster	05
Unit cost of cleaning up per yard of plaster	06½
Unit cost of inside plastering complete per yard of plaster	30.6
Unit cost of plaster per yard of plaster	10
Unit cost of sand per yard of plaster	01.3
Unit cost of lime per yard of plaster	00.3

Unit cost of plastering labor per yard	$0 17
Unit cost of millwork, hardware and nails	601 96
Unit cost of labor on same	158 47
Unit cost of electrical work (including 2 motors) "contract"	164 00
Unit cost of sheet metal work	295 90
Unit cost of asphalt roofing	282 00

Agnews Commissary Building.

Unit cost of excavation per cubic yard	$0 75$\frac{8}{10}$
Unit cost of forms complete per cubic yard of concrete	4 74
Unit cost of form labor per cubic yard of concrete	3 14
Unit cost of form material per cubic yard of concrete	1 60
Unit cost of concrete complete per yard	20 19
Unit cost of reinforcing steel per yard of concrete	3 48
Unit cost of reinforcing steel labor per yard of concrete	93
Unit cost of crushed rock per yard of concrete	1 36
Unit cost of sand per yard of concrete	55
Unit cost of gravel per yard of concrete	83
Unit cost of cement per yard of concrete	3 47
Unit cost of concrete workers per yard of concrete	2 98
Unit cost of inspector and timekeeper per yard of concrete	63
Unit cost of form lumber per M	19 82
Unit cost of labor on reinforced steel per ton	13 88
Unit cost of asphalt roofing per square yard	61
Unit cost of brick per M (old)	2 00
Unit cost of brick per M (new)	14 54
Unit cost of sand per yard	1 84
Unit cost of lime per barrel	1 84
Unit cost of teams and labor per M brick	52
Unit cost of sand per M brick	1 02
Unit cost of lime per M brick	41
Unit cost of cement per M brick	2 37
Unit cost of material for steel reinforcing per M brick	44
Unit cost of labor on steel per M brick	63
Unit cost of labor on steel per ton	62 15
Unit cost of scaffolding per M brick	28
Unit cost of masons per M brick	7 62
Unit cost of tenders per M brick	2 71
Unit cost of reinforced brickwork complete per M	23 89
Unit cost of material for metal lath and furring per yard	44
Unit cost of labor complete per yard metal lath and furring	25
Unit cost of steel workers per yard metal lath and furring	19
Unit cost of furring per yard metal lath and furring	06
Unit cost of metal lath and furring complete per yard	69
Unit cost of painting material per square yard	06½
Unit cost of painting labor per square yard	42¼
Unit cost of painting complete per square yard	48¾
Unit cost of outside plastering complete per yard	1 50
Unit cost of cement per yard of plaster	34
Unit cost of sand per yard of plaster	12
Unit cost of lime per yard of plaster	05
Unit cost of plasterers per yard of plaster	63
Unit cost of tenders per yard of plaster	30
Unit cost of scaffolding per yard of plaster	05
Unit cost of cleaning up per yard of plaster	01
Unit cost of inside plastering complete per yard	33
Unit cost of plaster per yard	09
Unit cost of sand per yard	01
Unit cost of lime per yard	00.3
Unit cost of plastering labor per yard	20
Unit cost of scaffolding per yard	03

TABLE I.

State Agricultural Fair Grounds.

Stock Building.

Lumber and mill work	$977 28
Shingles	330 00
Hardware	34 33
Team work	113 31
Concrete, labor and materials	35 55
Labor, shingling	112 60
Carpenter work	477 20
Survey	10 00
Inspection	100 00
Total cost	$2,190 27

Area, 7,392 square feet; cost .2963 per square foot.
Cubical contents, 118,272 cubic feet; cost .0185 per cubic foot.
Building, open frame and concrete pier foundation.

Poultry Building.

Excavation	$7 50
Concrete, labor and material	38 25
Hardware, galvanized iron	578 46
Lumber and mill work	1,702 91
Glazing	249 00
Concrete floor labor and material	825 00
Carpenter work	796 75
Teaming	102 48
Tools	10 00
Survey	20 00
Inspection	150 00
Total cost	$4,480 35

Area, 7,500 square feet; cost, .597 per square foot.
Cubical contents, 180,000 cubic feet; cost, .0248 per cubic foot.
Building, frame and concrete pier foundation.

Two Lavatories.

Excavation	$37 80
Lumber and mill work	495 87
Hardware	9 77
Plumbing	125 00
Teaming	21 37
Carpenters	132 00
Inspector	75 00
Total cost	$896 81

Area, 616 square feet; cost, $1.455 per square foot.
Cubical contents, 8,624 cubic feet; cost, .0104 per cubic foot.
Frame structures.

TABLE II.

Veterans' Home.

Social Hall Floor. (Concrete on wooden floor.)

Carpenter removing old floor	$62 25
Labor on concrete	50 12
Gravel	24 00
Secondhand lumber	2 50
Expanded metal	56 84
Hardware	35
Cement	44 52
Inspector	80 00
Total cost	$320 58

1,655 square feet floor; cost, .1937 per square foot.

Moving Uncle Tom's Cabin.

Rent of moving outfit	$33 00
Carpenters' labor	34 00
Common labor	14 50
Inspector	45 00
Total cost	$126 50

Moved 360 feet; cost, .3514 per foot.

Repairs to Roof.

Plans	$146 63
Lumber. new and second hand	157 66
Hardware	265 88
Freight	147 03
Sheet metal and skylights	204 08
722 M shingles	1,998 30
Teaming	23 50
Removing old shingles	79 82
Labor on sheet metal	77 44
General carpenter work	104 22
Painting	12 50
Labor placing shingles	677 20
Inspector and foreman	496 00
Expense account	14 17
Tools	3 60
Total cost	$4,408 03

772 M shingles laid for .877 per M.

Repairs to Kitchen.

Lumber and mill work	$284 85
Concrete, labor and material (37¾ yards)	240 59
Filling earth	26 25
Teaming material	22 25
Hardware	14 84
Steel bars	65 94
Tile (Welsh quarries)	87 95
Excavating	38
Plumbing, labor and material	244 99
Carpenter, labor	316 95
Total cost of repair	$1,304 99

TABLE III.

Stockton State Hospital,

Cow Barn.

Excavation	$111 37
Concrete, labor and materials	175 77
Lumber	1,655 36
Carpenter work	412 15
Hardware	138 51
Painting and material	105 76
Inspector	965 00
Total cost	$3,563 92

Area, 13,000 square feet; cost, $2.74 per square foot.
Cubical contents, 298,600 cubic feet; cost, .0124 per cubic foot.

Sidewalks.

Sand filling	$14 40
Teaming	584 00
Steam roller	37 50
228 yards crushed rock	586 21
290 yards gravel	475 16
1,094 barrels cement	1,635 03
73¼ yards sand	4 90
Grading	1,325 97
Sand fill	74 69
Labor on concrete	435 98
Sewer pipe	15 60
Inspector's salary	831 40
Lamp black and building paper	37 80
Preliminary expense	87 63
Total cost	$6,146 27

41,638 square feet of walk; cost, .1473 per square foot.

NOTE—Inmate labor is charged at the rate of 50 cents per day; attendants at $1.84 per day; institution teams at $4.

TABLE IV.

California Polytechnic School, San Luis Obispo.

Machine Shop.

Excavation	$331 13
Concrete, labor and material	826 62
Lumber	1,958 65
Mill work	571 99
Plumbing	567 00
Hardware	180 72
Tools	14 72
Paint	75 00
Teaming	173 15
Shingling	58 00
Carpenter labor	723 75
Painting	42 25
Inspection	200 00
Total cost	$5,723 00

Area, 4,070 square feet; cost, $1.406 per square foot.
Cubical contents, 97,686 cubic feet; cost .058 per cubic foot.
Building, frame and concrete foundation.

Forge Shop.

Lumber	$403 01
Mill work	93 47
Hardware	45 32
Paint	37 00
Plumbing	70 45
Concrete, labor and material	80 02
Excavation	109 13
Shingles and labor	140 80
Carpenter labor	226 65
Labor painting	82 50
Teaming	8 16
Inspector	130 00
Total cost	$1,426 11

No plans.

Propagation House.

Concrete and floor work	$292 15
Lumber and mill work	352 98
Hardware	55 44
Paint	27 68
Plumbing	249 40
Trucking	39 01
Carpenter work	289 38
Inspector	135 00
Total cost	$1,441 04

Area, 1,260 square feet; cost, $1.14 per square foot.
Cubical contents, 17,640 cubic feet; cost, .081 per cubic foot.
Building, frame and concrete foundation.

TABLE V.

San Diego State Normal School.

Asphalt Macadam.

Crushed rock	$281 25
Asphalt, as per specifications	157 50
Hauling, spreading and rolling, heating and mixing	1,988 12
Total cost	$2,426 87

Barber Asphalt Company, contract price, $3,000.

20.341 square feet 4½ inches thick in center and 3 inches at sides; cost per square foot, .119.

TABLE VI.

Agnews State Hospital.

Bakery.

Excavation	$231 50
Excavation for oven	8 91
Reinforced concrete and floors	10,860 31
Reinforced brick masonry	4,657 62
Metal lath and furring	578 86
Inside plastering	361 35
Outside plastering	1,141 71
Carpentry, including glazing	760 43
Plumbing	66 25
Electric work (contract)	164 00
Asphalt roofing (contract)	282 00
Sheet metal roofing (contract)	295 90
Painting	68 54
Fquipment, charges	297 55
Ovens (contract)	2,733 00
Total cost	$22,507 95

Area, 5,196 square feet; cost, $4.33 per square foot.

Cubical contents, 108,760 cubic feet; cost, .2069 per cubic foot.

NOTE.—This building is constructed of reinforced brick and concrete roof. The ovens were a separate contract from the building proper.

Commissary Building.

Excavation	$249 50
Reinforced concrete	9,558 30
Brick masonry	4,253 62
Metal lath and furring	523 49
Inside plastering	280 58
Outside plastering	1,067 03
Carpentry, including glazing	763 42
Plumbing	90 79
Electric work (contract)	124 00
Asphalt roofing (contract)	305 00
Sheet metal work (contract)	240 00
Painting	48 81
Proportion of plant charges	297 55
Total cost	$17,752 11

Area, 5,196 square feet; cost, $3.417 per square foot.

Cubical contents, 108,760 cubic feet; cost, .163 per cubic foot.

This is a reinforced brick and concrete roof building.

TABLE VII.

State Insectary, Sacramento.

81 yards concrete, labor and material	$410 30
Teaming material	54 80
Rough hardware and tools	61 70
270 square feet sidewalk, including steps	298 34
Excavating 110 yards earth	69 48
Cost and labor of insulation	39 19
Cost lumber and shingles	957 56
Cost finish hardware	101 69
Cost mill work	1,210 11
Cost paint and labor	533 73
Cost plastering and material	276 46
Plumbing (contract)	250 00
Sheet metal (contract)	190 25
Electrical work (contract)	140 00
Ventilating and motor (contract)	502 00
Galvanized iron stack (contract)	112 00
Teaming	7 43
Carpenter labor	1,425 46
Glazing (contract)	151 00
Inspector and foreman	425 00
Total	$7,466 50

Area, 3,334 square feet; cost, $2.24 per square foot.
Cubical contents, 60,012 cubic feet; cost, .124 per cubic foot.
This does not include heating plant.

TABLE VIII.

Repairs to State Printing Office.

Lumber	$133 95
Iron work	527 18
Hardware	86
Labor, carpenters	356 00
Teaming	1 50
Inspector	75 00
Architect's office	87 74
Total cost	$1,182 23

Placing timbers in old structure.

CONTINGENT APPROPRIATION AND MISCELLANEOUS WORK.

The contingent appropriation of $5,000 per annum is inadequate for the work of the Department. The current expenses with an office force of forty or sixty employees is beyond the appropriation, and necessarily there has been a deficiency of about $2,500 per annum. The traveling incumbent upon the heads of the Department has occupied about one half or more of the time, and this necessarily takes considerable of the contingent money. It is urgently requested that this appropriation be made sufficient to carry on the work of the Department without hindrance.

As State Engineer, I have attended several Good Road meetings, made several trips of investigation on the river, and have personally investigated all the work of the Department. The Department has been instrumental in bringing about several innovations in some branches of its work, notably—established the fact that our mountain State roads may be accelerated in speed and cheapness of construction by the use of a steam traction shovel; has employed the new plan of water cushions for weirs, ditches and waterways, thus effecting valuable State work; has made a flexible brush mattress with cable, concrete, and brush, which makes an ideal revetment or river bank protection, and has employed in brick building construction a reinforcing metal, giving added strength to brick walls from shock or horizontal forces. All these ideas are proving very effective in their various capacities and will result in placing such work on a better basis.

RIVER CONTROL.

Ages ago Suisun bay probably extended from Iron Canyon at the north to Tejon Canyon on the south, a distance of more than 400 miles, with an average width of 50 miles. By the continual, if slow, accumulation of detritus washed down from the surrounding mountains, the water was driven farther and farther toward the Golden Gate, and the two great valleys, the Sacramento and the San Joaquin, were formed by this accretion from the highlands.

This great inland sea which stretched along the foot of the sierras had finally become but a remnant—Suisun Bay, lying just inside the gateway, now called Carquinez Straits.

The area of Suisun Bay is about 50 square miles at ordinary stages. Contributary to it were 100 square miles of marsh lands covered by the tide daily.

In the deltas of the Sacramento and San Joaquin rivers are more than 500 square miles of land, with an elevation of less than ten feet above low tide. The range from low to high tide is six feet at low stages of the rivers.

The principal islands forming the deltas of the two rivers named are as follows:

Lower Sacramento River.

Sherman, area	14,000 acres
Brannan, area	7,000 acres
Andrus, area	7,600 acres
Grand, area	17,000 acres

Lower San Joaquin River.

Bouldin, area	6,400 acres
Mandeville and Bacon, area	13,200 acres
Roberts, area	60,000 acres
Rough and Ready, area	1,600 acres
Union, area	42,000 acres

These islands were all formed by the gradual deposition of fine material brought down from the mountains by the annual floods of the rivers. By the action peculiar to sediment-bearing streams, the banks were built up higher than the surface of the land some distance away, and nearly all of these islands have that characteristic. Being surrounded on all sides by the streams that built them, the borders of the islands forming the banks of the streams are higher than the land at the interior, so that they may be correctly described as being "saucer-shaped." The rims of these bowl-like islands were sometimes raised well above tide level, as at the upper end of Grand Island, where the bank was about fourteen feet above low tide, and at the head of Roberts Island on the San Joaquin, the level of the bank was eighteen feet above datum. The lowest place on this island being about low water level. The lowest point on Grand Island was more than ten feet below low tide and twenty-five feet or more lower than the rim at the upper end of the island.

Before mining in the mountains had sent untold millions of yards of detritus down the rivers, and before levees had been constructed along their banks in attempts to keep the water off the adjoining land, the waters of the rivers were free to spread over the floor of the valley whenever they were swollen to a volume larger than the space between the banks.

As stated above, the banks were higher than the land at a distance. This condition produced troughs or basins between the rivers and the rising ground of the foothills. The fall from the top of the river bank is sometimes as great as ten feet in a thousand for short distances. For instance, the Colusa Basin, lying west of the Sacramento River, is, in one place, fifteen feet lower than the river bank two miles away.

Prior to the commencement of farming on the low lands and the building of protection levees, the high waters ran over the banks filling the basins to the flood level of the stream and obliterating all trace of the channel, excepting as the banks were marked by the growth of trees.

During the flood of 1853 the conditions are described as presenting to view a "sea of water" from Sutter's Fort (in Sacramento City) westward to where Davisville now is, and southward to Stockton, the water being three feet deep over the banks of the river.

The conditions that caused more than one million acres of land to be inundated by the waters of Sacramento River, and as much more by the San Joaquin and its tributaries, were simply insufficient size of channels.

Hydraulic mining began to send débris down very shortly after Marshall's discovery of gold in 1848, and naturally great quantities of it were arrested in the channels where the slight gradients reduced the velocity of the water.

Very soon after the miners began washing the hillsides into the rivers, farmers were attracted to the rich lands lying partly submerged on the islands of the river deltas, and began, in 1852 or 1853, to build levees to keep the water off the land. The first attempts were at the upper end of Grand Island, where small levees were built to keep off the flood waters from the river. These were extended from time to time along the banks of Old River and Steamboat Slough, until finally the entire island was encircled, not, however, without suffering breaks at different times. Of late years the levees have been so strengthened that they withstood the flood of March, 1907, while the nearby islands were flooded.

The settlement of other islands followed; more levees were built; the river more or less successfully "fenced" off from spreading over the lands. The result of all these changes, filling the river beds with débris and narrowing the channels with encroaching levees; has been to raise the water plane all along the course of the streams.

The Commissioner of Public Works estimated, in 1894, that the Sacramento River from the mouth of the Feather to Suisun Bay had been reduced in cross-sectional area one third. Low water stages at Sacramento are five to seven feet higher than in 1849.

In the summer of 1908, just passed, the river registered 5.3 feet on the Weather Bureau guage at "K" street wharf—the lowest recorded in twenty-one years.

In its original condition the river was never able to carry its flood waters, notably in 1853 and 1862. Although the latter date was twelve years after hydraulic mining had commenced, the fact that low water registered 0 on the gage as late as 1856, and in 1861 it was down to 1½, is taken to indicate that not much filling had occurred up to that time, and yet, as before stated, the water ran over the banks all along its course converting the valley into a sea ten to twenty miles wide.

In attempting to devise any scheme for relieving the situation as it exists in the Great Central Valley, it is found that the interests of navigation, drainage, flood control, and irrigation are so intimately connected that one can not be discussed without considering the others.

And they seem to pair off in antagonisms although so interdependent. Large reservoirs to intercept the flood are advocated, and could undoubtedly be made to greatly lessen the dangers of the flood waters. But to construct and maintain them without regard to their use for irrigation would not be thought of. Yet, if they are to be useful for the latter purpose, they must be filled with the first water that comes in sufficient quantity, else they may not be filled at all. If they are filled then, when the flood arrives their capacity to absorb the flood flow is gone. So the one interest is opposed to the other.

Navigation requires a small channel in order to husband the water into a narrow space when low; flood protection demands a waterway of ample dimensions. Elaborate schemes have been worked out to reconstruct the main channels of the rivers so as to carry ordinary high stages, with overflow structures to take off the surplus into auxiliary channels, confining it between embankments so as not to flood the lands, all of these by-passes to converge into the one channel entering tide water.

Another scheme is to dredge the detritus from the river channels, using the material dredged to strengthen the levees on the banks. In the case of the Sacramento River, it has been estimated that the channel from Feather River to Suisun Bay has filled from six to fifteen feet and that from 80,000,000 to 120,000,000 cubic yards of detritus are lodged there. Let all of this be taken out and still the channel will not carry ordinary floods, much less the extraordinary. The river from near Colusa to the mouth of the Feather has channel capacity to carry within its banks only about 30,000 second-feet, yet the records show that at Iron Canyon sixty miles above there were, March 19, 1907, 204,000 second-feet flowing. The stretch from Stony Creek, where it has the first opportunity to overflow, to Colusa the gradient of the river, determined from the slope of the low water-surface, is 1.29 feet per mile, and for the stretch of small channel way, from Colusa to Feather River, the fall is only $\frac{84}{100}$ foot per mile, so it can readily be seen what extensive changes are necessary to be made in that stretch to make the river carry all the water that Iron Canyon sometimes delivers.

Whatever may ultimately be done for the solution of the several problems, it will all fail of giving protection to the islands of the Sacramento delta unless extensive channel enlargement and rectification be done at the confluence of the Sacramento and San Joaquin rivers.

All of the drainage of the Sacramento must enter into the bay through a narrow pass. Just above Rio Vista, where the overflow from up the river coming down through the Yolo Basin reënters the Sacramento through Cache Slough, the river was formerly 2,600 feet in width. This has been reduced to about 1,800 feet by means of jetties. A few miles below this the channel is only 700 feet between banks. When a flood wave is rolling down the river it must mount higher and higher as the channel narrows, and when it meets the incoming tide, five feet high, forming, as it were, a waterdam, it must ride on top of this tidal dam, with disastrous results to the shore embankments.

It would seem imperative that this constriction must be removed as preliminary to any scheme for river improvement above.

The conditions on the Sacramento may be briefly summarized as follows:

The river enters the valley at Iron Canyon carrying an observed maximum of more than 200,000 second-feet. The channel of varying capacities, and tortuous course, traverses the length of the valley the first sixty miles in the trough, thence occupying a ridge from which the land slopes either way to lower land on either side. After running for sixty miles the stream is augmented by Stony Creek, from the west. Thence the channel, even in ordinary floods, begins to spill its surplus which gathers into and floods Colusa Basin; the water in this basin being constantly added to by overflows at intervals nearly the whole length of the river, to Knights Landing. Some is spilled along the upper reaches over the east bank and is picked up by Chico Creek, Angel Slough, and other channels, let into Butte Basin, thence into Sutter basin and reënters the river at the lower end of the latter. When the flood wave has passed and the water level in the river lowers, Colusa Basin begins to return its water to the river through Sycamore Slough near Knights Landing. From Stony Creek to Feather River, a distance of 117 miles, the Sacramento has no tributaries, but sometimes, as in 1907, when Butte Basin is already full, Feather River breaks over into it, and the basin not being able to hold any more, overtops the levees along the river near Colusa, engorges the stream and adds to the outflow toward the west into Colusa Basin. Feather River, which also occupies high land, receives Yuba and Bear rivers from the east, overtops its banks and flows into Sutter Basin on the west, swelling the volume already received from Butte Basin.

The Sacramento having parted with its surplus in the upper reaches would now be able to keep within its banks except for the additions received from its east side tributaries just named. Being swollen by these waters, it now begins to flow out over the west bank, almost in a broad sheet, the water running to lower land in Yolo Basin. Arriving at Sacramento City, the river is again reinforced by the American River. This stream, when gorged, flows over its banks to the north, filling American Basin, which already has received considerable quantities of water from the Sacramento River and the foothill drainage. Below Sacramento the river would, except for levees, overflow both banks, all the way to Rio Vista, that to the west running into Yolo

Basin, and on the east flowing toward Stockton till intercepted by the Mokelumne, by which stream it would be conducted into the San Joaquin. Near Rio Vista the waters that were discharged into Yolo Basin are returned to the river through Cache Slough, the quantity here entering, having been largely increased by the hill drainage from the west of the basin.

All along both banks of all of the streams, levees have been constructed in attempts to keep the water from overflowing the adjacent lands; but never a flood has occurred yet that they were not breached, entailing great loss to the lands and crops inundated. Millions of dollars have been spent in these efforts at protection and other millions lost because of their failure.

The first thing that strikes the notice of even a layman in examining the river is the glaring fact that the levees are too close to the banks almost everywhere. It is less than a thousand feet from the wharves of Sacramento City to the levee on the opposite side and thirty feet, height measured on the gauge, endangers them. The maximum amount of water entering the valley above Sacramento City on March 19, 1907, has been estimated at more than 500,000 second-feet. Think of carrying that amount between banks 1,000 feet apart. With the present channel capacity, it would have to move at a velocity of sixteen feet per second, or if it were possible to restrict the velocity to ten feet per second, it would require the levees to be raised about twenty feet higher, neither of which conditions could possibly be attained.

The problems of the maintenance of navigation, protection from floods and the drainage and irrigation of land have been studied by able engineers, and good, bad and indifferent solutions offered; but the first requisite is a unification of purpose and harmony of effort among the various and varied interests involved. That having been attained, methods may quickly be determined upon and carried out.

Is not the addition of 1,000,000 acres in the Sacramento Valley, and nearly as much in the San Joaquin, to the permanent wealth producing area of California worth a united effort? An empire in extent, of as productive land as exists anywhere.

Japan supports forty-eight million people within a territory the size of California, only one sixth of which is tillable land, and nowhere has that country land or climate to compare with the Great Central Valley of California, the superior productiveness of which can more than furnish the conditions required for our people when it is brought under ideal conditions of protection and cultivation. But to give it the wonderful development it should and can have, all interests must unitedly strive for and accomplish restoration of navigable conditions, protection from flood disaster, and reclamation by drainage and irrigation where these improvements are required.

From the data of surveys, gauge readings and information furnished by the United States Geological Survey, and a study and observation of the Sacramento River, it is very evident that in a general comprehensive scheme of improvement for flood conditions of the river we must open wide the mouth of the stream, make cuts to obviate the bad sharp turns below Rio Vista, then continue up the river, cutting out all bad bends. We should begin at the mouth of the river rather than from any midway or other point and pursue the work up stream. If the stream were straightened out above Rio Vista to Red Bluff then would the waters rush down and pile up in the lower reaches of the river, endangering vast tracts of reclaimed lands. Probably the most important part of a general scheme for flood control is the systemization of the location and construction of new levees and the proper replacing of the old ones. The levees are now perched upon the bank ridge so close to the water line that a few feet of erosion endangers them and perhaps thousands of acres of land with crops. The eagerness to get all the land possible under cultivation and the system of dredging in vogue along the Sacramento and San Joaquin rivers, makes the near river bank the most convenient place for a clam shell dredge to drop the material, and also save the maximum of acreage. There are so many diversified opinions and interests involved that it is a difficult matter to get one or several landowners to begin the work upon a proper basis when his or their neighbors entirely disregard the plan. This is positively wrong, and some central authority should have power to compel the landowners to levee their lands in a way beneficial to the whole people affected by the reclamation.

This authority must have powers that command the whole levee system. Until we adopt a plan of this nature, a recurrence of the disastrous breaks caused by flood waters will continue, and relief can not be expected. For flood relief there must be sufficient cross-sectional area to carry away the highest water.

Undoubtedly, near the mouth of the river there must be provided such area way between levees that when the flood waters happen to meet the high tide, the river waters may pass over the crest of the tide,

The dredging of the Sacramento River or the San Joaquin River within the tidal area would not materially assist the passage of flood waters, but beyond the reach of the tidal flow then the increased depth is a vast factor in that the cross-section for the flow is increased.

Again, dredging the rivers for navigable purposes has its advantages, and I believe if dredging could progress on the Sacramento River and deposit the material in the proper location for a complete levee system, it would prove a great boon to the landowners. The problem of navigation can be cared for without materially helping the property owner, yet the same owner in his endeavors to keep his land under reclamation has largely assisted the navigability of the river. It is only fair and just that the landowner in his undirected struggle against flood waters receive some consideration at the hands of those who propose to benefit navigation. In fact, the two interests should work in true harmony and accord to accomplish a good deep river and one capable of caring for flood waters.

PROGRESS OF RIVER WORK.

By act of the legislature, approved March 21, 1907, there was appropriated $125,000 to be expended by the Department of Engineering "for rectifying and improving the channels of the Sacramento, San Joaquin, and Feather rivers, and such other river channels of the State as the Department of Engineering may determine, and to improve the navigability of said streams."

The damage to the river work wrought by the floods of 1907 appearing to be too great to be fully restored with the funds available when the Department of Engineering took charge of the rivers, it was decided to do that work which seemed most urgent, and the Consulting Board adopted as its policy, that where work was to be done that was plainly of immediate benefit to contiguous property interests, those interests should be required to furnish funds to cover part of the expense of the work planned, and that all rights of way should be given free of cost to the State.

At the time the Department of Engineering was organized and succeeded to the duties of the Commissioner of Public Works, the only work which had been commenced and not completed was as follows:

Near Marysville it had been intended to make a cut-off across Eliza Bend, in Feather River, and a contract had been made to clear the right of way of timber and brush. The price agreed to be paid under the contract was $111 per acre for clearing 25¾ acres, aggregating $2,847.25. Payments had been made to the amount of $2,080.20 by the Commissioner of Public Works. When the Department took charge it was found that only 21.83 acres had been cleared, and as the time limit of the contract had long expired, and further, the Department had decided to abandon the proposed cut-off, it declined to allow the remainder of the clearing to be made and settled for the amount actually cleared, amounting to $2,425.25 less $2.080.20 previously paid. Prior to the flood of 1907 the Commissioner of Public Works had undertaken some protective work at Rocky Point, on the right bank of the Sacramento River, at the town of Washington, Yolo County.

In the fall of 1907 the Department of Engineering constructed a stretch of brush revetment along the levee at the same place, and used some old brush left over from the work of the Commissioner of Public Works, and for which payment had not been made. The brush was piled on the river and before using any from the pile the Department had it measured and found the pile to contain 64.70 cords. That amount was used and credited to the contractors, Messrs. Clark and Henery, who had furnished it to the Commissioner of Public Works.

The work accomplished by the Department in channel protection and rectification since assuming the duties thereof May 11, 1907, is best given by outlining the work on each improvement.

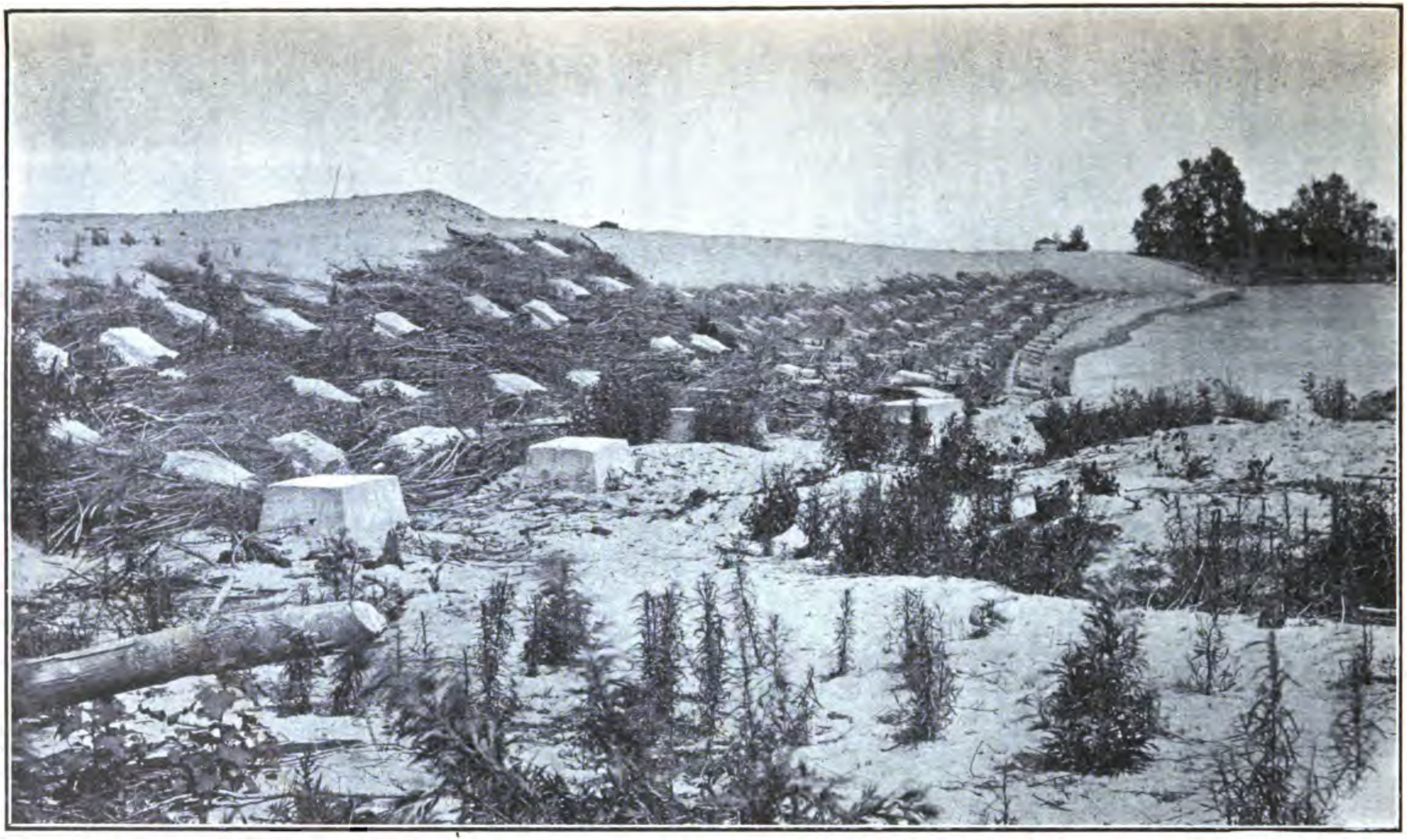
At Rocky Point, on the right bank of the Sacramento River, at the east end of the town of Washington, the flood of 1907 had very nearly overtopped the levee, and had eroded the embankment badly. This is a particularly dangerous point, being so situated as to receive the force of the current from American River, cutting diagonally across the Sacramento. Many times a break has been threatened here, and great quantities of rock have been placed on the slope of the bank on numbers of piles driven to protect the bank from washing. But the whirling current cuts away the bank at the foot of the slope causing the rock to roll into the river, leaving the upper slope exposed. The protection used by the Department in this instance is a flexible brush mattress, which it is believed will be effective in protecting the bank and stopping further erosion. Its character and method of application will be described further on. The estimated cost of this work as designed was $3,502.40, but after construction was commenced it was deemed best to extend the work beyond the limits first intended. The total cost was $4,879.61. The people of Washington and vicinity and the county of Yolo contributed one half of the expense of the work.

KRIPP BREAK.

The high water of March, 1907, caused a break in the levee in the right bank opposite Y street levee in the city of Sacramento, on the Kripp farm. This break occurred about the place of the Payne break of several years ago, and carried away part of the structure used in closing the latter, the expense of which was more than $50,000.

The effect of this break was to cover many acres of land with sand, rendering it valueless for cultivation, and an immense volume of water poured into the Yolo Basin, already well filled from overflows occurring farther up the river. The effect of this vast outflow on the channel of the river along the city water front and for some distance below the break was very marked; increasing the depth above and shoaling below.

Being unable to obtain satisfactory offers from dredge men for closing the break by contract, the Department hired a dredge and crew, paying $160 per day of twenty-two hours. The levee required to close the break was 1,600 feet long, 24 feet maximum height, and 16 feet wide on top, and containing 102,489 cubic yards of earth. The estimate of cost was



FLEXIBLE BRUSH MATTRESS ON SAND FILL, KRIPP BREAK, SACRAMENTO RIVER.

$7,687. The actual cost of building the levee, including superintendence and inspection, was $5,667.64, or 5½ cents per cubic yard.

To protect the embankment from wash the face of it along the lower half of its length was revetted with the standard flexible brush mattress adopted by the Department. The cost of the revetment was $2,773.95, making the total cost of the closure $8,448.25. One half of the expense was paid by private and public interests affected, and the other half by the State.

TISDALE WEIR, TEMPORARY REPAIRS.

The concrete weir at Tisdale ranch, Sutter County, about six miles below Grimes on the Sacramento River, had become undermined by the flood of 1907, and when the high water of 1908 began running over it, a portion of the concrete apron broke off and was carried away. To prevent the destruction of the entire structure, a flexible brush mattress was floated on and suspended like a curtain, over the broken parts which effectually arrested the undercutting and prevented further damage. The method adopted was effective for a temporary repair, but had no real permanent value.

BRANNAN ISLAND.

The west shore of Brannan Island, from the site of the Zeile wharf southward, was attacked by the high water of 1907, the levees washed away and the shore line in places moved inward. The levees were restored by the reclamation district, but the waves and tide driven by continuous northwest winds continually ate into the newly placed embankments. At the request of the district trustees, the Department of Engineering placed nearly three quarters of a mile in length of flexible brush mattress on the face of the embankment, the district paying one-half of the expense. The revetment did not extend as far as it was desired to make it, but it had to be curtailed for lack of funds in the district. There should be several hundred lineal feet added in order to protect the ends of that already placed.

SHERMAN ISLAND.

Two places where the levees on the north shore of this island were being eroded by the waves were revetted with flexible brush mattress. The mattress at Jap Landing was dropped in eighty feet of water, and successfully protected the bank. In this instance, as in the others, the property owners paid half the cost of the work.

The extent and unit cost of both Brannan and Sherman Islands revetment work will be found in the tables given for river work.

MERKELEY LEVEE.

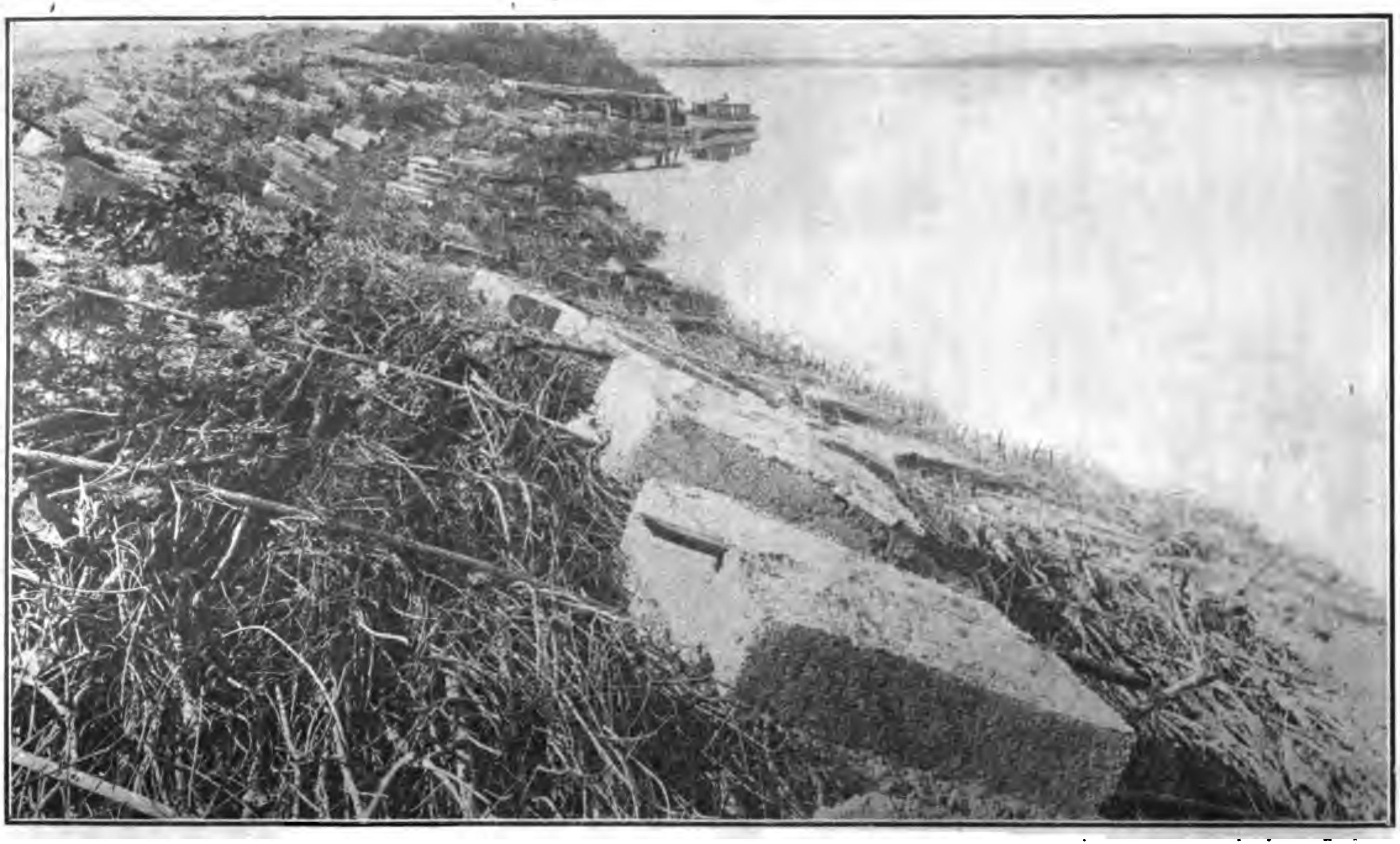
During the spring of 1908, the river bank began caving very badly on the east side of the river, along the rear of the hop-fields a short distance south of Sacramento City.

The Sacramento Southern Railroad occupied the levee, and the caving became so bad as to threaten the track, and seriously alarmed the people in the vicinity. The reclamation district and the railroad, each agreed to pay one third of the expense of revetting the threatened bank, which was done, the State paying one third.

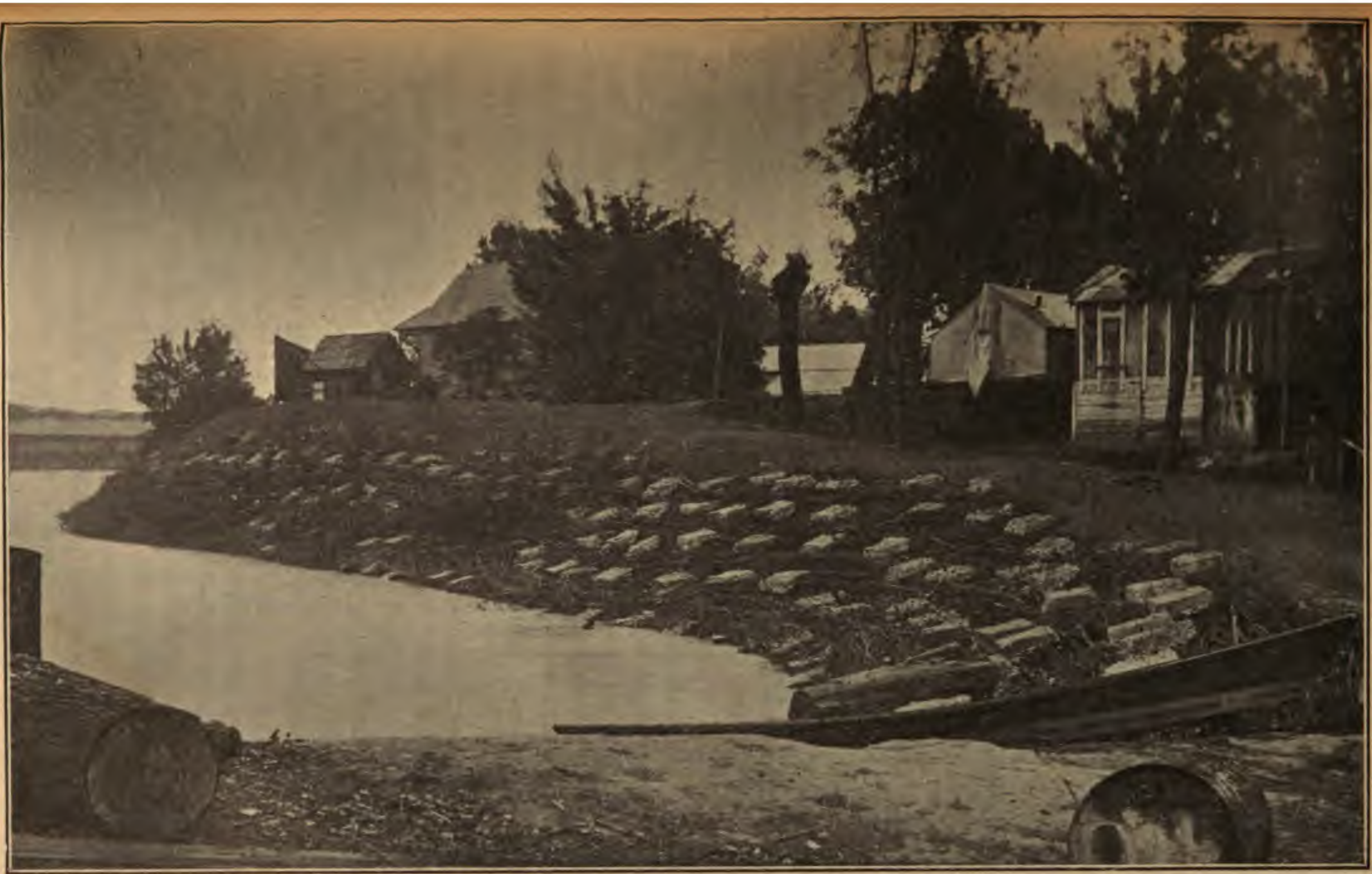
The revetment introduced by the Department of Engineering as a protection to river banks is quite a departure from the kind that had been used before. The method that was formerly used was to make a mattress of brush fascines, usually woven with wire or cable, and weighted down with loose rock laid on top of the mattress. If the slope of the bank below the water line, where it could not be graded, should be steep, no rocks would lie on it. Should erosion take place at the lower edge of the mattress, the latter would drop down, the rocks roll off and then the brush would rise with the water, be torn loose and carried away.

NEW FLEXIBLE REVETMENT.

The type of revetment now constructed by the Department of Engineering has grown out of a plan successfully originated by myself in bank protection work along Eel River, Humboldt County. Five years ago, the plan in crude form, was employed by the State to inaugurate channel rectification and arrest bank erosion for that stream. The developed plan consists of a mattress composed of brush fascines eight to twelve inches in diameter and about twenty feet long, bound with wire. These fascines are laid double, breaking joints, and woven over and under with three galvanized wire "strands" or cables, one-quarter-inch in diameter. Galvanized anchor cables three quarters to one inch in diameter, are laid on the slope extending from the barge floating in the stream to upon or over the levee to a safe point where a line of concrete blocks are sunken in the soil and are connected by a one half to three-quarter-inch diameter galvanized cable. These anchor cables are fastened to the line attaching together the line of "deadmen," or as called by this Department, anchor blocks. The anchor cables are spaced about eight feet centers and are attached on the water end to a line of cable passing through heavy concrete blocks made on the barge. These concrete blocks are called by the Department sinker weights. After this skeleton of cable and concrete work is set and ready, the mattress is woven on top of these cables and the mattress is tied or lashed to the anchor cables beneath the mattress every six feet. After the mattress is woven to its desired width another cable, three-quarter-inch diameter and galvanized, is drawn down over the mattress directly over the anchor cable. It is fastened to the anchor cable at six or eight feet intervals through the brush. The ends of this top cable are fastened



FLEXIBLE MATTRESS FOR REVETMENT, SHERMAN ISLAND. PLACED 1908.



FLEXIBLE MATTRESS REVETMENT, ROCKY POINT, YOLO COUNTY.

to the anchor cable on the land end by a cable clip just above the brush mat and the water end is made long enough to reach the sinker block where it is fastened. Also, just at the water edge of the mat the anchor cable and the top cable are fastened together.

Above the water the mattress is woven in place on the ground which has been prepared by grading to a uniform slope. When the waters edge is reached the weaving takes place on the cables suspended over the water by placing planks on the cables. The barge is held off shore by spars or struts which are held taut by shore lines to the barge. After the mattress is completely woven, blocks of concrete two or three feet square and from six to twelve inches thick are placed on the mattress, the size and distribution of which depends upon the figured buoyancy of the brush and the force of the current to be resisted. These blocks are moulded in place on the mattress and thoroughly fastened to the top cable usually with a turn or knot of the cable firmly embedded in the concrete. When the mat is thus made ready the barge is shoved away, permitting the structure to sink and conform to the bank slope. The mattress so made will, because of its flexibility, conform to the variations in the slope of the bank below the water where it could not be graded. Should the current cut under the edge of the mattress the weights will drop down, carrying the mattress down as the earth is washed away, and all—mattress and weighting—being secured by cables to the anchorage on shore, will continue to hang over the bank like a curtain. No weights can roll off and release the brush.

In the work on Eel River the brush above the water line soon sprouted and grew into a dense live mat that no current could move. It is well known that wood under water and constantly saturated will last indefinitely, so if a mattress will grow into live brush above the water its life should be indefinitely long.

It was found in the Sacramento River that not much brush would grow above the wash of the waves, on account, in a great measure, of the hot sand upon which it was laid. The department had not the facilities for keeping the revetment wet at the several places where it was placed and as the property owners could not be persuaded to do so, it has not been done. To remedy that omission as far as possible and get a live mat to growing an effort will be made this winter to stake all of the mattress laid down with live willow stakes which, when driven well in the ground during the spring of the year, will give a strong healthy growth. The principle involved in this form of mattress is to protect the bank beneath the low-water mark by that portion that is indestructible, and get a growth above ordinary water so that it may eventually form a live mat entangled with concrete and cable which will extend from high to low water. (See photograph of Eel River growth, printed later.) When the willow has reached a sufficient growth, it then should be trimmed back, and allowed to spread out thickly, but not grow too tall. This protection will give a natural living growth all cabled and concreted together in one mass, which will resist a great velocity and consequent erosive influence.

SAN RAFAEL CREEK.

For many years the people of the city of San Rafael had endeavored to have the channel of San Rafael Creek improved. The creek is a narrow, somewhat tortuous tidal stream connecting with San Francisco Bay a few miles north of San Quentin Prison. There is a very large freight traffic conducted on the creek by sailing scows, but as there was no water at low tide, and only about five feet at high tide, it would sometimes take a loaded scow thirty hours, or three tides to work her way from the mouth of the creek to the city wharves.

A petition had been presented to the Commissioner of Public Works for relief, and $5,000 was pledged as a fund to pay part of the expenses of any improvement that might be undertaken. The Commissioner had surveys made, and recommended that the creek be dredged.

Upon the transfer of the duties of the Board of Public Works to the Department of Engineering, negotiations were renewed by the people of San Rafael, surveys were made and plans worked out.

It was desired to make a cut across a long curve near the mouth of the creek, shortening the distance very much, and making a straight channel which would be a great advantage to vessels navigating it. It was found, however, that there were interests opposed to changing the channel from its natural course, and as it would entail long delays to undertake to carry the matter through the courts, the cut-off was abandoned and a contract let to dredge the creek to a depth of four feet from the mouth to the first wharf, just inside of the city limits, and make it sixty feet wide.

The estimated cost was $9,450, and the contract was let for $7,951. After completing the channel as stated, it was decided to continue work to the head of navigation, 2,400 feet farther, which was done, a channel being excavated to a depth of four feet below low tide. This extension brought the expense up to $10,589, one half of which was paid by the citizens.

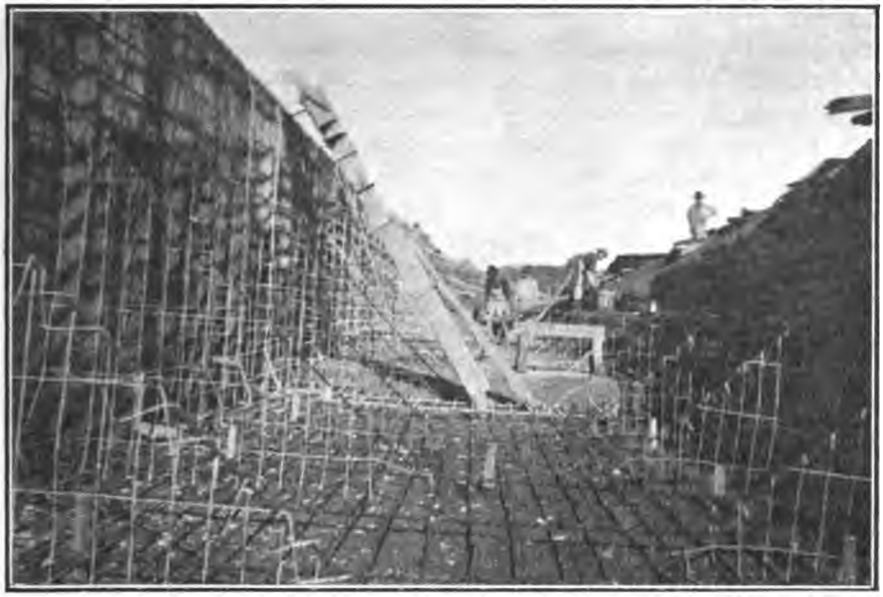
The contract price per cubic yard of material dredged was five and eighty-nine hundredths cents (.05 89-100). Since the completion of this work the matter of the extension of the dredging from the mouth of the creek into the bay across the mud flats for about 3,000 feet was taken up and after applying through Colonel John Biddle, U. S. A., in charge of this work for the Federal Government, for permission to do this work, and receiving the sanction of the War Department, advertised for bids for the dredging and construction of one thousand (1,000) feet of protective timber bulkhead. December 28, 1908, is the date set for receiving bids.

TISDALE WEIR—REPAIRS AND IMPROVEMENTS.

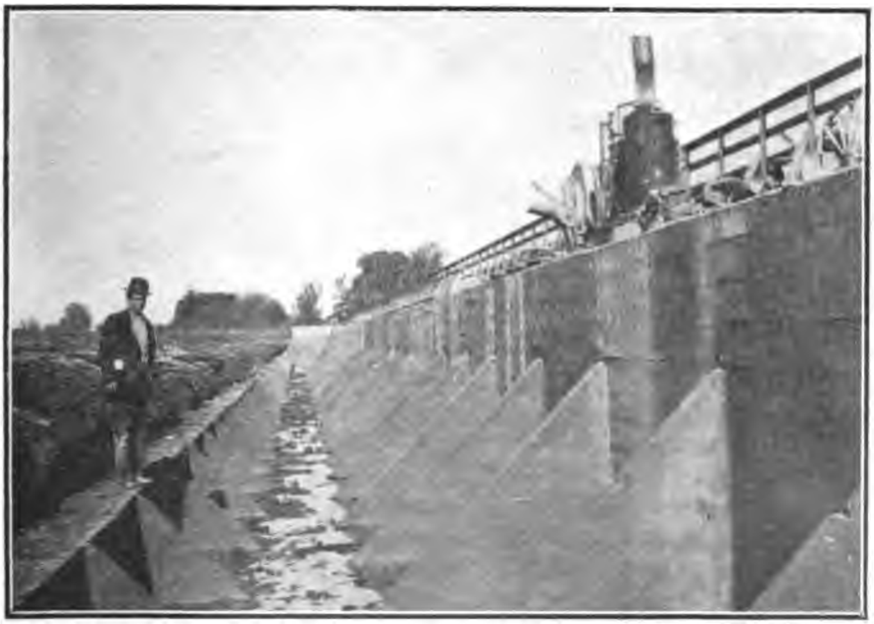
Owing to the fact that Sutter County had constructed a bridge alongside the weir, on the upstream side, which was considered by the Department of Engineering to have contributed some to the partial failure of the weir, and which was considered a menace to its safety; and further, it did not appear from the records that the county had ever obtained formal official permission to place the bridge there, it was thought the county should contribute something toward repairing the broken structure. Negotiations were opened to secure a contribution from the county, which delayed work for some time. Finally, the Sutter County Board of Supervisors appropriated $1,000, to aid in restoring the structure, and assured the Department that the county would use every effort to prevent log jams from lodging against the bridge and endangering the weir. Plans having already been prepared, bids were asked for and a contract was awarded the Western Bridge and Construction Company on their, the lowest, bid of unit prices to repair the weir where damaged, and add a reinforced concrete water cushion to the weir to prevent further cutting on the land side where the water poured over the structure. Formerly the weir had steps to drop the water down easily from the crest of the concrete to the inner ground level. Nearly always water flowing over a structure, and having a flat apron to leave on, gradually erodes the ground and finally destroys such a structure. To prevent this, we designed a water cushion 1,150 feet long, 12 feet deep, with a lip 3 feet high, into which the water can drop and form a cushion exactly upon the principle of a natural stream of water flowing over a fall causing a hole into which the water falls and eddies when it leaves the hole without cutting force. This may be seen on any mountain stream. Views of the construction of this new and important work are herewith presented.

IMPROVEMENTS AT MARYSVILLE.

Ever since the streams began filling with débris the confluence of the Feather and Yuba rivers has given trouble. The Yuba, just before joining the Feather River, originally made a sharp bend, and the current struck that of the latter upstream. The Yuba has quite a steep gradient, and since mining began has brought an enormous quantity of detritus with its rapidly flowing water. The Feather River, with much less velocity, has a far greater volume of water than has the other. Just below the confluence the river, now known as the Feather only, makes two short bends, forming a sharp reversed curve like the letter "S." The effect of these two curves, known as Shanghai and Eliza bends, is to retard the flow and make the current more sluggish. The small, heavily laden Yuba River, striking the large volume of water in the Feather in such a way as to oppose the force of



REINFORCING SCHEME TISDALE WEIR, SACRAMENTO RIVER.



WATER CUSHION, TISDALE WEIR, SACRAMENTO RIVER, 1,200 FEET LONG, DROP 12 FEET.

the currents against one another, suddenly checks the velocity of both, and they drop a large part of their respective loads. In this way the beds of the streams have been raised until that of the Yuba, a short distance from Marysville, is thirteen feet higher than land inside of the levees. The Federal Government several years ago made a short cut changing the mouth of the Yuba so as to enter the Feather River lower down and at an angle pointing down stream. While this was undoubtedly an improvement upon the natural conditions, yet the sharp bends below continued to hold the water back and raise the flood plane against the Marysville levees.

Many times the people of Marysville, Yuba City, and contiguous territory had endeavored to have something done to relieve the situation.

The Board of Public Works in 1906, began clearing the ground preparatory to making a cut across the chord of Eliza Bend, but had not commenced excavation when the Department of Engineering succeeded to the duties of the Board. At the solicitation of the people concerned, the Department made a thorough examination of the situation, with the result that the Eliza Bend cut-off was abandoned and a more comprehensive plan adopted.

The Department plan is to divert the Yuba from a point above Marysville conducting it southerly for about two miles and entering Feather River at the lower end of Eliza Bend and in a direct line with the course of the Feather, below. Then to make a cut from the present junction of the two streams, in a line in prolongation of the course of the Feather from the Marysville-Yuba City bridge, and intercepting the Yuba cut about one third of a mile above the junction of the latter with the Feather River channel. This will cut out both Shanghai and Eliza bends, unite the two streams at an acute angle, so that their currents will each help the other instead of being opposed as at present. A right of way nine hundred (900) feet in width was secured for the Yuba cut-off last winter, and the land for the cut cleared of timber. Later, a contract was let for the dredging of a channel, to begin at Eliza Bend and work upstream as far as the railroad bridges.

Owing to delays in getting a dredge up the river, low water came on and nothing could be done during the summer.

In the mean time the Department proceeded to have a channel excavated from the point of diversion to pass under the railroads and highway bridges to connect into the head of the proposed dredge cut. It should be explained that there has been a small high-water channel existing along the line of the proposed cut for several years and both the Northern Electric and Western Pacific railroads had provided for the possibilities of the enlargement of the channel by constructing bridges with ample waterways where they cross the stream. These bridges, of course, prevent dredges excavating further upstream. Therefore, from the south side of the Northern Electric railroad bridge to the point of diversion the channel had to be excavated by teams and scrapers. This work was completed in September last.

The contractor having the contract for dredging obtained the use of a dredge which has just completed a job of levee building a few miles below Eliza Bend, and now has made about 800 feet of the cut.

Plans have been submitted to the War Department, and as soon as permission has been obtained and the necessary rights of way secured, work will begin on the Feather River cut. All of those who are familiar with the conditions that have existed there for years, are sanguine that the changes being made will materially lower the flood plane, and reduce the danger to the levees and property for the whole section of country around Yuba City and Marysville.

MOKELUMNE RIVER.

In common with all other rivers of California which traverse the mining regions of the mountains, the Mokelumne River has been injured by reason of the accumulation of débris in its channel.

Because of neglect its navigability had become destroyed in that portion above New Hope Landing. Great snags and drifts had lodged in the channel, and these had caused bars to form effectually preventing the passage of boats. In 1905 the property owners along the river united in an effort to have the river improved. They raised over $30,000 for the purpose and the State contributed about $15,000, with which amount the river was snagged and the bars cut out for a length of ten miles from New Hope Landing, and terminating at the Galt-New Hope bridge, crossing the river near the village of New Hope. Thus ten miles of navigable water was added to the highways. Last year the property owners along the river from the present head of navigation to the railroad requested the Department of Engineering for assistance and offered to contribute two thirds of the expense of improving the channel from Galt-New Hope bridge to Woodbridge dam.

A careful survey was made of the river, with frequent cross-sections over the entire length to be worked. It was decided that the improvement should consist of destroying snags and drifts, dredging out bars that form shoals, and the making of some thirteen or fourteen cut-offs across short bends. The petitioners desire that only about five miles of the channel be opened the first year. In addition to contributing two thirds of the expense of the work, they also agree to procure free privileges for all work contemplated. An obstacle to the immediate commencement of the work is the presence of the highway bridge above named, which prevents the passage of a dredge or snag-boat to begin operations. This bridge has been ordered by the War Department to be removed, and the counties of Sacramento and San Joaquin, jointly have prepared plans for a drawbridge to take the place of the fixed bridge, and it is understood that construction will soon begin. The Department is now cutting off the trees for fifty feet on either side of the river for a distance of about five miles above the Galt-New Hope bridge. This cutting away the timber from the banks prevents the chances of trees toppling into the stream where the bank is caving away and becoming a menace to navigation. The work is also preliminary to the use of the dredge, so that snags may be lifted out and placed well back upon the bank.

SAN JOAQUIN RIVER.

Near the confluence of the Tuolumne with the San Joaquin River, in Stanislaus County, a stream called Walden Slough diverts from the former, running westerly. About a mile below the confluence named a large stream named Finnegan Slough leaves the San Joaquin River, and running northwesterly, is joined by the Walden Slough, coming from the east. Some two miles farther down, another stream known as Amphlett Cut, runs north from the main river and joins Finnegan Slough. The combined waters of these three streams continue in a northwesterly direction approximately parallel with the parent stream and enter the Stanislaus River some two miles above its junction with the San Joaquin. In their course these three sloughs, individually and combined, flood large tracts of land. The Commissioner of Public Works closed all three of the sloughs with dams at or near their respective diversions from the river, but the first high water occurring after their completion washed them away.

Walden and Amphlett sloughs are not of sufficient size to do much injury to navigation on the San Joaquin, although they carry enough water to flood many acres of land.

Finnegan Slough, however, is very large, having about one third as much cross-sectional area as the river has at that point. It has materially enlarged in the last few years, and having a steeper gradient than the river, it draws a large part of the water away from the latter. The effect of the division of the water is surely to cause the river to shoal below that point. The conditions are being aggravated each year, and in the interests of navigation on the river should be remedied.

Some of the property-owners whose land is injured by the flooding petitioned the Department to restore the dams that had been washed out. Examinations and surveys were made, and it was found that to close the streams with dams and to construct the additional works necessary to protect them from again being washed out would cost about $17,000. In effecting the closure as planned all of the overflow land along the sloughs would be reclaimed. Only one group of landowners were willing to contribute toward the enterprise, and they were only able to pledge about fifteen per cent of the estimated cost.

The surveys made by the Department show that between Finnegan Slough and Amphlett Cut there are three very sharp curves in the San Joaquin River, and that cuts aggregating less than three fourths of a mile in length would shorten the river to one and a half miles between these points, whereas it is three and a half miles by the present channel. The making of these cut-offs would be strictly in the line of navigation improvement, and at least a portion of the expense might properly be borne by the Federal Government, but there are no funds available for it. Even if the cuts were made, the dam in Finnegan Slough, if not the others, should also be made. The cost of making the cuts, dams, and protection levees required would be a total of $26,000. These cuts, when made, would divide the lands, and set off small tracts from the main holdings, and it was found that the property owners would not grant rights of way without compensation for the lands cut off.

Under the circumstances it was not deemed expedient to do any work on the project at this time.

MOONS BEND.

At this place, situated on the Sacramento River at the head of Butte Slough, about four miles below the town of Colusa, during March, 1907, the river was running bank-full, when it was suddenly augmented by a large quantity of water from the Feather River overflowing and crossing the plains north of Marysville Buttes. It overtopped the Sacramento River levees, virtually crossed that stream, and broke the levees on the west side. Flowing thence into the Yolo Basin, along the arc of Moons Bend (sometimes called Butte Slough Bend), three bad breaks were made in the west levee. This levee is controlled by the owners of the adjacent land on the west, not organized into a district or association.

These property owners concluded to construct a new levee across the chord of the bend, and applied to the Department of Engineering for assistance in doing so, urging that along the line of their proposed levee would be the location of a cut-off whenever the scheme of rectification and reclamation proposed by the so-called Dabney Commission should be completed, and that they (the landowners), were ready to convey to the State the right of way that eventually would be required in consideration of the assistance to be given them by the State at this time. The proposition was considered by the Department, but in the mean time the property owners proceeded to construct the levee upon the line selected by themselves. The cost of the levee was stated to be $15,750, and the property owners requested that the State should pay one half of it. Afterward, they modified their claim and offered to grant the State one third interest in the right of way for a cut there for one third of the cost to them of building the levee.

Finally, it was proposed to grant the right of way, provided the State pay one third of the cost of the construction of the levee. The matter was taken before the Advisory Board, but as yet nothing has been done.

OAK HALL BEND.

During the spring of 1908, complaint was made to the Department that the river bank near Oak Hall, four miles below Sacramento, was caving badly and endangering the levee. A survey was made, but the conditions not appearing to be dangerous, and the property owners not evincing sufficient interest to provide money for a portion of the cost, no construction was done.

LAKE EARL.

For many years the owners of land annually submerged by the waters of this lake have sought to obtain assistance from the State for relief. The legislature, by act approved March 17, 1907, appropriated $15,000 for "Permanently draining Lake Earl in Del Norte County," contingent upon a like sum being deposited in the treasury of Del Norte County for the same purpose, by the persons interested, thus making a fund of $30,000 for constructing a drainage canal.

Surveys had previously been made for such a project under the direction of the Commissioner of Public Works.

In June, 1908, Mr. P. M. Norboe, Assistant State Engineer, made an examination of the lake, and his report thereon follows:

July 10, 1908.

MR. N. ELLERY,
State Engineer, Sacramento, Cal.

DEAR SIR: In regard to the proposition to drain Lake Earl, Del Norte County, I have to report:

The lake is a body of fresh water lying along the coast and separated from the ocean by a narrow range of sand dunes. It is fed by a number of short creeks rising in the hills toward the east and by the run-off of the rainfall from the slopes of the hills and valley land adjoining the lake.

The lake is subject to a fluctuation in depth from extreme high water in the spring to extreme low water in the late summer of about eight feet. The difference between average high water and average low water being about six feet. The extreme low water plane is about two feet below mean low tide. The range of the summer tide being about five feet, would place extreme high water in the lake one foot above high tide and six feet above low tide. It would seem then that the water might be drawn down about six feet by a gravity drain, and any reduction of the water plane below that must result from evaporation.

No contour surveys of the lake have been made, but it is believed that ordinary high water covers about 5,500 acres, which is reduced to about 3,500 acres at ordinary low water, making 2,000 acres uncovered, and the maximum reduction in depth between these stages is six feet. This assumption would give a volume of 6,000-acre feet of water to be drawn off.

About 5,600 acres of "lake land" has been segregated to the State as swamp and overflowed land, not quite all of which becomes submerged; but there are some lands not classed as swamp and overflowed land which does become covered with the high water. Most of the swamp and overflow land has been purchased from the State, excepting in the deeper portions, where it seldom becomes exposed.

The lake is in two parts connected by a narrow strait. The western arm at one point approaches within a few hundred feet of the ocean shore, and the sand ridge between is so low that often during storms the ocean waves dash over into the lake. The owners of the submerged lands frequently cut a channel from the lake to the ocean, holding back the tide with temporary bulkheads until the right time. Upon a receding tide, the bulkheads are suddenly removed, when the head of water in the lake is sufficient to scour out a large channel which continues to discharge until a returning tide chokes it up with sand, when the work must all be done over again.

The high water surface of the lake is sometimes lowered in this manner several feet, and large areas of submerged land uncovered.

By the timely drawing off of the water in the manner stated the farmers are enabled to obtain fair crops of hay, but the method is very expensive and not always successful.

After the water has been drawn off as much as can be, as just described, evaporation will lower the surface of the lake to a point even below the level of mean low tide in the ocean, but the process is so slow that the land is uncovered so late in the season that it does not produce herbage of much value, and unless the season happens to be rather drier than normal, the recession on account of evaporation may be nil.

Should some means be found to keep the level of the lake surface low during the rainy season, then evaporation would materially lower the low water plane, enabling profitable crops of forage to be grown on the land that is already owned, and would farther extend the area of uncovered lands, which would immediately be purchased from the State, and thus add quite an amount of property to the tax roll.

It would not be a difficult matter to construct a conduit from the lake to the ocean, through the narrow ridge separating the two bodies, and to provide the conduit with automatic gates to prevent the sea water entering when the tide should be higher than the lake.

The distance from permanent deep water in the lake to low water in the ocean is about 3,000 feet, which would be the length of conduit required. The outfall and tide gate chambers would have to be built particularly strong to resist the pounding of waves and of huge drift logs that continually drift ashore.

The beach along here is shifting sand, and this presents a problem that would be extremely difficult of solution. Should expensive outfall works be constructed no one can predict how long they would remain operative, nor how soon the sand would choke them up, even completely covering them. It is well known that sand beaches exposed to the free flow of tide and storm waves are always shifting; that a storm one day will build up immense sandbars, and in a few days remove them, building somewhere else.

The writer feels quite sure that efficient drainage works can be installed for the amount of the appropriation therefor, to wit, $30,000, but would hesitate to recommend their location at the place mentioned for the reason that they might be wholly useless within a week after completion.

There is a place farther south where the shore and the bed of the ocean for a long way out is rock, free from shifting sand, where outfall works would never be troubled with sand. But to reach this point, a conduit would have to be about two and one half miles long, with excavation nearly forty feet deep for a mile or more, and the whole line through dense timber.

A drain on this line would probably cost more than twice the amount of money available.

A drain depending upon gravity flow can not lower the water in the lake below the elevation of low tide in the ocean, or even quite to that stage, and any lowering of the lake surface below that point will depend solely upon evaporation.

Owing to the benefits that could accrue, in a public sense, to the addition of so large a tract of land to permanent productiveness, and the uncertainty of being able to maintain effectively a gravity drain that can be installed for the amount of funds available, it is suggested that the same or better service can be had by means of a pumping plant.

Such plant, having the requisite capacity, should not cost to install more than $10,000, and the extent of the drainage accomplished would be under complete control.

The cost of operating a pump to maintain the lake at its present low water stage would be probably between 50 cents and $1.00 per acre per year. If a larger area shall be uncovered, the cost per unit would be reduced.

I recommend that no plan be adopted without further investigation, including field surveys, to determine the area and volume of water to be disposed of.

Respectfully,

P. M. NORBOE,
Assistant State Engineer.

I have closely observed and am familiar with the conditions of wind and tide which prevail along the northwest coast, and therefore agree with and approve Mr. Norboe's conclusions that the successful operation of a gravity flow outfall for Lake Earl, discharging into the ocean in an open roadstead with sand bottom, and practically without hydraulic head, would be very doubtful. The risk of failure is so great that the expenditure of a large sum in experimentation is not warranted by the apparent chances of success.

FLOOD PROTECTION FOR STOCKTON.

While the Department of Engineering is not directly connected with the project now being executed to prevent the city of Stockton from being flooded, yet the work being in line with river correction, the Department may properly take cognizance of it.

Mormon Slough is a channel having its source in the foothills east of Stockton. Its course through the plains traverses a low and flat country, subject to inundation from the San Joaquin River on the south, and also from the Calaveras River on the north. A branch of the latter, leaving the main river near Bellota, runs southward spreading over the country and flowing into Mormon Slough. The latter named stream passes through the city of Stockton, and is the channel used for navigation from Stockton to the San Joaquin. Being a sluggish tidal stream, when the San Joaquin is in flood and overflowing streams above are gorging it, disastrous consequences ensue to the city.

Some years ago Congress made appropriation for the purpose of making a "diverting canal" to take the water of Mormon Slough from above the city of Stockton, convey it across the country north of the city, and discharge into the main channel of Calaveras River west of Stockton, from whence it reaches the San Joaquin below.

This appropriation was made with the provision that the State of California, or the property holders, should furnish a free right of way. March 25, 1903, the legislature appropriated $60,000 to be expended in payment for rights of way for the diverting canal. Some lands were purchased and others obtained by suits in condemnation instituted by the Commissioner of Public Works. The total cost of the right of way was more than $86,000, the city of Stockton paying all above the $60,000 appropriated by the State. During the summer just passed work was commenced under the direction of the War Department, and is steadily progressing at the date of this writing.

THE SAN JOAQUIN RIVER.

The San Joaquin differs largely from the Sacramento River, inasmuch as its mouth is about three times the width of the mouth of the Sacramento. This gives an easy flow off for the flood waters, but in places may make shoals, which for navigation purposes can be remedied by jetties permitting the high waters to overflow them. Farther up the San Joaquin is found numerous sharp bends, making the river difficult of navigation, and also greatly retarding the passage of flood waters. These conditions should be taken in hand and receive some attention. The navigability of this stream is of vital importance to the people of the San Joaquin Valley and should be jealously guarded by them. At Firebaugh, the official head of navigation, it is understood that during the dry season flow scarcely any water is permitted to remain in the stream on account of a private diverting dam for irrigating purposes. This is a direct hindrance to navigation, and its maintenance there should be investigated by the Federal Government—the guardian of the navigable waters of the State.

EEL RIVER WORK.

During the year 1905, the State began the jetty and revetment work for the rectification of the channel of Eel River, and the protection of the banks from erosion. Before this time attempts had been made in a small way to prevent the inroads of the flood waters of this stream, but all proved futile. It was, therefore, with skepticism that the people of that vicinity viewed the work of the State. However, there has now elapsed three years since the inauguration of the work, and during this time two severe floods have been resisted effectively by both revetment and jetties. It is now concluded that the Eel River can be successfully treated by the method employed by the State and compel the waters of the river to maintain their channel without cutting the whole Eel River Valley and leaving a slightly covered gravel bar in the place of highly cultivable soil.

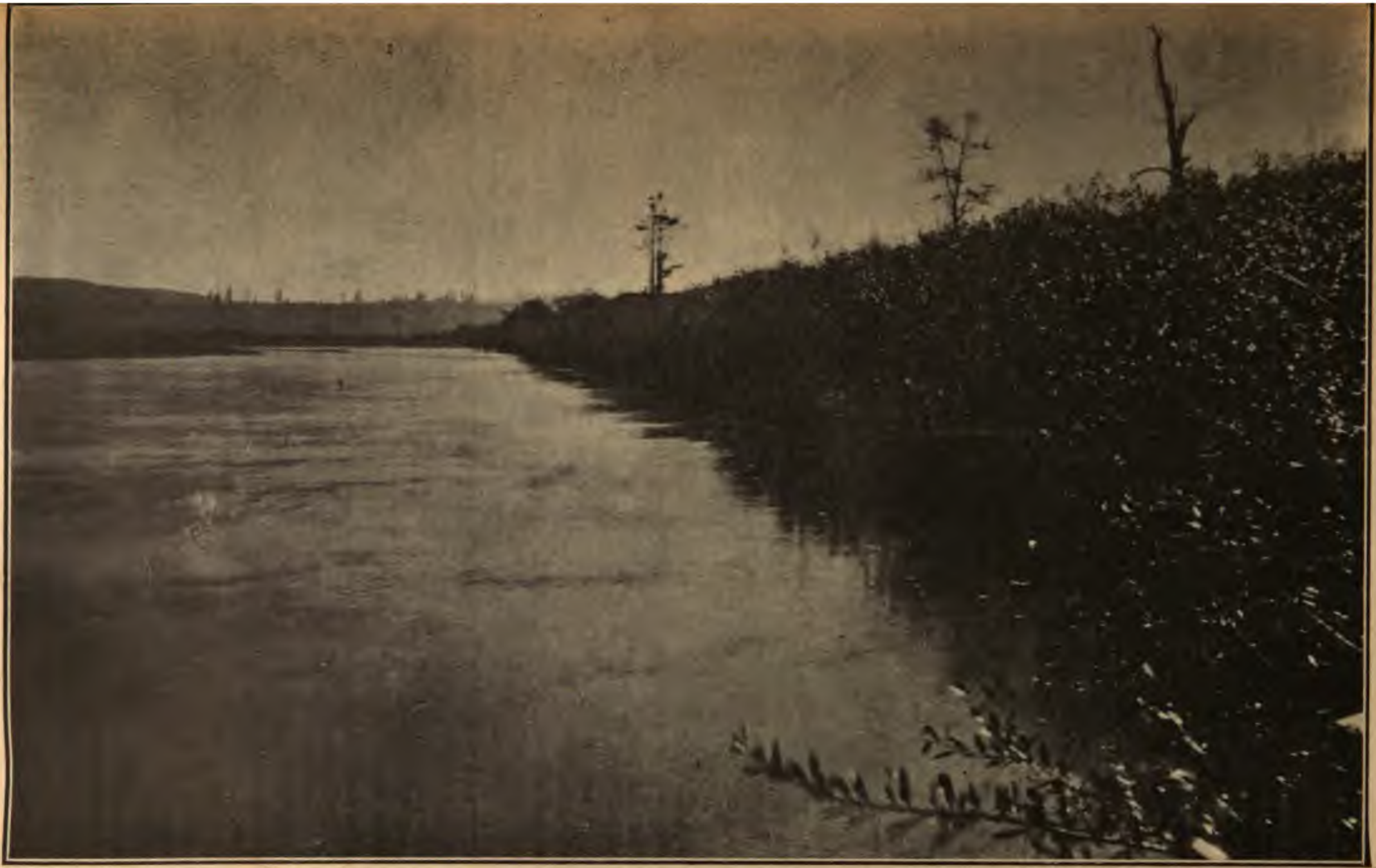
It is estimated that to revet and properly handle Eel River from the mouth of the Van Duzen to the mouth of the Eel it would require an expenditure of approximately a million dollars. A great amount of good efficient work could be done by the property owners if they would look closely to the State's work and copy after it. Do not try and reduce the cost materially, or else you are doomed to failure. The strong current, and the trees and débris it carries in flood time, makes the task of handling its waters one of the most difficult on the Pacific coast. I will herewith present a description of this work and what it has accomplished.

Two jetties were constructed, one on the west bank of the river above Pleasant Point, and the other on the east bank of the river near Bryant's ranch. The west side jetty is about 800 feet in length, and was constructed by driving piles about twelve feet centers each way, then brush was woven in between these piles and wired tightly down on the gravel bed. A layer of brush about five feet thick was placed, then about two feet of river gravel poured on top of it. Again brush, then gravel, until the required height was reached, then the piles were sawed off and large concrete blocks were placed on the structure completely covering it. These blocks were wired or cabled to the pile heads, the wire having been embedded in them. On the upstream side huge blocks weighing ten tons were placed, dipping about forty-five degrees upstream. The east jetty was of the same construction as the west one, but only 450 feet in length. Both structures were placed in the stream at an angle of about forty-five degrees to the bank, *i. e.*, pointing downstream, so that huge redwood trees weighing about two hundred tons would not strike the jetty squarely but obliquely in order that the full impact may be partially dissipated along the line of jetty.

The revetment began on either side of the river at a gravel bar growth near the old bank line for complete protection of the beginning, in order that the river could not get behind the work. It continued downstream to the shore end of the jetty, then temporarily stopped. Here I might state that all jetties not above the water plane always cause an eddy or swirl that cuts the bank just below them. This is what happened to the Eel River jetties, but when a crescent-shaped cut occurred it was revetted and then at the downstream end of such cut the velocity neither ran up or downstream, making a nil point where bank cutting was practically prevented. This made an excellent stopping point for the revetment, for it has been found that if the revetment did not extend to a point of protection it would gradually be eaten away at its downstream end.

The manner of constructing the revetment for this stream was new but having faith in the natural protection furnished stream banks by willow growth, I proceeded upon the theory that such growth, induced by revetment, would have the same effect.

The banks were sloped back to about forty-five degrees, then along the crest were sunk the anchor blocks with a line of cable or wires running through and attaching them together. At the lower edge of the bank the same was done with sinker blocks. Then wires were run up and down the bank from the anchor block line to the sinker block line. Upon this skeleton brush, not in fascines, because the work was during the dry season and above water, was woven about thirty inches thick with the body of the brush lying pointed about forty-five degrees upstream to permit of an easy diversion of the flowing water. On this brush were drawn wires directly over the lower wires from the line on the crest of the bank. This top line of wire was fastened through the



GROWTH OF WILLOW BRUSH, EEL RIVER REVETMENT WORK, SHOWING LIVING BANK PROTECTION.

brush to the bottom wires the same as a mattress is fastened. Upon this flexible brush mat was set, in places, flat concrete blocks attached to the wire, and again long stretches were overlaid with river gravel, serving the same purpose as concrete but considerably cheaper. This work has proven very effective, and it is recommended that more of it be done so that no chance may be taken with the waters from above eating away the land and eventually destroying the work. The natural beginning point for this work is the mouth of the Van Duzen River, where no damage can accrue to its upper end.

During 1907 there was considerable additional concrete placed on the west jetty and 850 feet of revetment as described above done on the west bank below the jetty, and 2,500 feet of revetment done on the east bank below the jetty.

In the late fall of 1906 the county undertook to revet the bank beyond our work on the east bank, but the high waters of that winter practically destroyed the whole of it.

Again in 1908, this Department revetted 765 feet of the west bank and 2,160 feet of the east bank. All the work done during the years 1907 and 1908 was accomplished in an excellent manner, and will be an effective part of the scheme. The east bank is now revetted between two gravel bars of the river and crosses one bad sag, which has been specially treated with a large anchor block in the stream to hold the revetment against large trees that may partially float and partially drag through the sag.

It is recommended that an appropriation of $15,000 be made to continue the west bank work below the mouth of Van Duzen River, and to maintain the present work.

MAINTENANCE AND GENERAL RECOMMENDATION ON RIVER WORK.

To keep the construction of the river work up to its proper condition, and to promote and continue the work begun entirely under the State's superintendence, it is recommended that $250,000 be appropriated and placed under the control of the State Department of Engineering.

PEAT LEVEES.

The rich and valuable islands of delta sections of the San Joaquin and Sacramento rivers are enclosed by levees constructed largely of peat soil, and during flood flows are severely damaged, some almost beyond repair.

At the solicitation of the owners of Jersey Island in the spring of 1908, in my official capacity, I visited and examined, without charge, the levees of the property in an endeavor to outline a plan to successfully meet the needs of all the peat districts. I therefore present my report thereon, with the belief that it may assist in bringing this vast territory to its proper development.

REPORT ON PEAT LEVEES, JERSEY ISLAND.

At your request, and after a personal examination of the levees of Jersey Island March 7, 1908, I beg to report my conclusions and recommendations for the building up, safeguarding, and maintaining the levee system of the island.

There appears to me a general lack of system in your levee work, with a consequent lack of strength to withstand the floods and the necessary resistance to the water damage. The primary consideration of Jersey Island, as of the other islands in the neighborhood, is a good system of levee building and maintenance. For neglect along this line may bring disastrous and irreparable damage to the land, and surely a financial loss, which might have been warded off by proper management of your levees.

Without good effective work along the line indicated your land has no secure valuation. It is, therefore, sound engineering and business to place your embankments against floods in the best condition.

Jersey Island, like the islands in the delta section of the San Joaquin and Sacramento rivers, is almost wholly composed of a peat soil, an accumulation of vegetable growth and alluvium deposits. This material, when used for levee work as has ordinarily been the practice, is not of much value, for during the dry season of the year it becomes exceedingly light in weight and cracks excessively, making a very dangerous barrier for high or threatening waters. When this material is first thrown up from the river or slough bed or sides, it has sufficient weight to make a fairly good levee, but on account of the porosity of the peat lands there is great liability of a subsidence or settling of the soil, permitting the levee to sink below the level attained when the dredgings were first placed in the embankment. This is augmented whenever the roots of the tule begin to decay beneath the new material of a new levee, thus allowing the soil to compress and greatly lessen its coherent strength. What is needed is a mass of roots that will take the place of the tule roots making a sort of grill foundation for the levee, and giving it, by this mass of roots, great coherent strength and resisting power. This idea can not be overestimated, since several practical examples have come before my observation in a professional way in such a marked degree as to leave no doubt of the efficacy of roots as a binding and sustaining power to weak or porous soils. For example, upon the reclamation of salt marsh land, I have observed a settlement or subsidence of the soil between sixteen and eighteen inches. This was due to the decaying of the marsh grass roots and the natural compression of the earth to occupy the voids thus created. Note the similarity of the tule roots in the peat lands. Again, my experience with river work has positively demonstrated the fact that roots from a good thick growth of brush give a supporting strength to the earth and make it almost impregnable to the erosive action of water. On Jersey and surrounding islands it will give absolute security. With the tule lands of the lower river sections there is still another levee weakness that must be met. The dry hot summers crack and dry out the levees until if they be subjected to horizontal water pressure from the outside they are liable to break and float away. Here again, a brush growth will bind together the dry levees, and, if properly cared for, prevent failure of this nature and as a supplementary help will prevent the large cracks of the levee. Let me here recite some facts in relation to this work that the advanced plan may be somewhat clarified.

The inherent principle of forestry and the conservation of river water is to obtain a growth over the drainage basins of the headwaters of the streams. This growth retains the moisture in the soil, thus preventing a too rapid run off. Apply this principle to your levees for the retention of the moisture, thus preventing cracks and giving more weight to resist flotation of the peat material.

From tests made of the peat soil of Jersey Island by my assistant, the following facts were deduced:

The specific gravity of this soil is .25, or, in other words, it weighs one quarter as much as the water. When saturated with water the peat developed a specific gravity of .8, or eight tenths of the weight of water, and that upon such saturation the volume increased to double its original size in the dry state. One cubic yard of dry peat weighs 405 pounds and has a flotation power of 1,270 pounds. One cubic yard of wet peat weighs 1,470 and has a flotation power of 190 pounds.

Certain conclusions must therefore be drawn as follows: Peat material built in a wet state into a levee will shrink about 50 per cent under the heat of summer, and with such shrinkage must come considerable cracking. It is too light a material when dried to make levees, unless it received some process to hold it against floating away, and that a well cultivated levee of this material cleared of brush is a positive absurdity. These facts have all been proven by actual observation.

Undoubtedly, you have observed how much more difficult it is to remove earth when interlaced with brush roots than to remove earth devoid of such roots. In handling earth materials in engineering practice for the past twelve years, I can safely state that in numerous instances the difficulty from such roots has doubled the price of the work.

Of the various kinds of brush I have tested on river work, the common willow variety seems the best suited to the purpose of holding in check the erosive power of the water and binding the earth material together. It is the natural barrier provided and is indigenous to all our streams. In the applications of this willow growth. the whole future security of the levee systems of the peat districts lies. The work done on Eel River by the State under my direction, and which has stood the severest of tests, has amply proven the efficient use of willow growth for protection purposes, and after what has been accomplished there with a friable soil, subjected to a torrential stream, I positively can not see how properly handled willow growth can do anything but provide the most secure levee capable of being constructed, and one that will resist any action to which your levees are subjected.

By planting the willows on the berm of the levee (space between the outside edge of the levee and the ordinary bank line) and up the outside slope, the roots will so interlace the soil as to give it vastly increased power against the water pressure of the waterways.

For the purpose of handling the levees enclosing Jersey Island the treatment is somewhat varied from new levee construction on peat lands. A sufficient levee height should be attained to prevent flood or tidal overflow, and good slopes should be given to the embankment, that the pressure of earth weight may be distributed and a more rooted mass may resist the water pressure.

A levee of 72 feet base, 12 feet on top and 8 feet high, of wet peat would have a good bearing area with an average pressure downward of one eighth of a ton per square foot. If you were to construct new levees of the aforementioned dimensions completely willowed, the cost should not exceed 90 cents per running foot. Drainage or seepage ditches should be approximately 100 feet inside of the central line of levee.

At the time of my examination I positively think the greater part of your levees is of sufficient height to resist high waters, and all they now need is the careful brushing completely over to give absolute security.

The Jersey Island property is subjected to the pressure of high water and the wave action caused by winds. Along Taylor Slough the principal danger lies in the high water and tide waters, while the San Joaquin River frontage is subjected to wave action. On Dutch Slough, except for about one half mile on the lower end where wave action is encountered, there appears no great danger from either flood, tidal, or wind action.

The matter of dredging material for levee building is very vital to any change or new method of levee treatment. Especially is this so where inconstant conditions might arise, such as subsidence of material, shrinkage, cracking of material, friability of soil, and lack of cohesion. To illustrate the points directly involved in the Jersey Island work, there is subsidence of material through roots decaying and compression of the large cracks in the peat, and there is lack of cohesion of binding together in one mass by noting the voids in the levee built of peat by the clam shell dredge.

Should there be employed a complete willow growth to bind the soil of the levee into one mass, and thereby prevent cracks, we would still be confronted with the possibility of some subsidence. To meet this condition, I recommend covering the whole levee, from about two feet of the seepage ditch to the very water edge at low tide, with a mass of willows planted on two feet centers. With this manner of growth an impregnable barrier will be created capable of withstanding all the water action met in the Jersey Island section, and so thoroughly binding together the levee as to make it a mass of reinforced earth, capable of sustaining its own and extra earth weight. After this has been done, we can add to the elevation of the levee very readily and easily.

Some form of suction dredge can be employed with certain efficiency. For example, there is a suction dredge now in operation in Germany, the Fruhling by name, that can pump about any consistency of material up to 90 per cent solids with only 10 per cent water. This dredge has a marvelous capacity by actual test. It pumps 6,500 cubic yards of mud material per hour against 900 cubic yards per hour for 5 to 4½ cubic yards bucket clam-shell dredge, costing the equivalent of the Fruhling dredge mentioned. Our ordinary 4½ cubic yard bucket clam-shell dredge deposits 130 cubic yards per hour at its best. This difference in efficiency and capacity seems almost incredulous, but is from actual working tests, thus giving a good and fair comparison. Such a dredge, with Mr. F. V. Wright's scattering device, would be ideal for filling between a heavy willow growth. A levee of even density without voids would be obtained very cheaply by this suction method.

FLOOD GATES AND SIPHONS.

My examination of the island revealed a serious defect in the employment of flood gates where siphons, extending up over the levees without damage in the least to the embankments, should have been used. I strongly recommend the disuse of flood gates and penetrated levees on account of great liability to receive improper maintenance and attention, thus subjecting the whole district so leveed to a dangerous plan. Water may be eating away the levee in or about the opening and suddenly burst forth without warning, carrying away a section of embankment and then possibly bring ruin to a vast tract, such as Jersey Island. I, therefore, recommend against flood gates and for siphon, that one dangerous point may be averted.

CROSS-LEVEES.

On the rear of your land at Jersey Island there has been constructed an independent cross-levee. This has been thrown up by a Marion shovel dredge, and assumes the form in section of a triangle with its apex uppermost. Later, this work must receive additional material in order to give it more body and more bearing area. An exception to this, however, is where the present levee rests on a hard pan and is thrown up to an excessive height. Here the earth may be leveled off, shoving the top part in toward your land, thereby giving sufficient body to make a good embankment. The planting of willows from its outside edge to its crest is an extremely good piece of work. I, however, recommend that on the inner side at least eight rows of willows be planted, extending from two feet of the seepage ditch, about two feet between rows in the direction of the levee crest. At the higher parts of this levee there should be planted willows, completely covering it. This to be done, however, only after the surplus material has been worked back as previously suggested. It is my opinion that this work be properly done, there is but small necessity for a dredge at the present time. The real salvation of the levees is not in expending money on machines to continuously pile the material higher, but to protect the material which is already placed at a reasonably safe height.

SEEPAGE DITCHES.

The seepage ditches of Jersey Island are in numerous places too close to the levee Let me call your attention to some serious results of this defect. The pressure of the natural earth level augmented by the levee material pressure, squeezes the side of the ditch out and thereby cause cracks that could be averted by placing the ditches a farther distance from the levee crest, say 100 feet. This is an important fact in peat land, and should receive proper recognition. I, therefore, recommend that any new ditches be made at the above written distance, and in some places where the levees show signs of weakness, the present ditches be abandoned and new ones dug at a greater distance from the levee.

The canal system was but casually studied, as this has only an indirect bearing on the levee arrangement and construction, and therefore I shall pass it, except to state that with a completely brush covered embankment, the control of the seepage water with pumps of ample power will be positive.

WAVES AND THEIR ATTENDANT WASH.

The whole line of frontage from Jersey Point up the San Joaquin River, with about the first one half mile up Dutch Slough, is subjected to an intense wave wash created by winds sweeping up from the bay. Efforts have been put forth to stop this damage, but nothing permanent has been accomplished. Stakes driven at intervals in two lines about eighteen inches apart, then filled with brush and wired down to the stakes, is the merest temporary makeshift, and should be replaced with a massive willow growth capable of coping with this destructive wash. From my experience with willow growth, I have conclusively proven the efficiency of such growth for the purposes mentioned. Again, walls of rock in some places have been constructed. These are insecure, but may be made secure by a willow growth bracing against such walls and making them permanent. By this brush growth, a barrier may be created that will astonish the most sanguine advocate of its use. If properly maintained and trimmed, there need be no apprehension of failure or wash where the levee is protected by this living natural barrier.

WETTING LEVEES.

The extensive cracking of your levees, consequent on a long dry season, should, I think, receive some remedial measures. In resorting to the willow protected levee, I would recommend that the levees be well watered during the summer, thus giving a twofold result; prevention of cracks, and greatly increased growth of brush. After the willow has attained a height of five feet the necessity of watering will be obviated. An ordinary pump, either operated by hand or by a gasoline engine, should be employed for this purpose, allowing the water to be sprayed on the soil.

MAINTENANCE OF WILLOW GROWTH.

After the willow has gotten a good start and sufficiently rooted, it should be trimmed and cared for the same as a well kept orchard. Five feet in height above the crest of the levee is ample. No single bush should be allowed to grow its main stem more than two and one half inches in diameter, but should be kept cut back. All such large branches on the water side or slope of your levee should be half cut off, then bent over toward the water. Such half cuts will conform to this position and give added growth and entanglement, greatly enhancing the protection. Allow the willows to grow as thickly as possible, always giving them advantage of fair treatment, and the rapidity with which it attains sufficient growth to be of practical benefit will not exceed two years in time. It should not, however, be supposed this method of levee treatment will give unreasonable results, for we must give it ample time to grow and root to prove its efficiency on peat soil.

TULES.

Do not destroy the tules which grow between the waterway and the levee. They add strength to the levee where needed. Their roots entangle the mass of mud or peat that may without their binding quality give way.

In conclusion, it is my earnest opinion that through the proper application and maintenance of a levee system, constructed to meet the requirements given in this report, security will be attained, so there need be no fear of breaks, and the property they protect must therefore necessarily be so enhanced in value as to prove the greatest economy in the use of a simple natural remedy, the willow growth. The present great cost of dredging, as practiced, will be almost wholly obviated in two years, and at the end of five years, the application of the foregoing scheme will practically eliminate dredging for maintenance purposes.

Respectfully submitted.

N. ELLERY,
State Engineer.

DAILY REPORTS.

A facsimile copy of a segregation sheet of our daily reports on river work is given in this report, so that the reader may see the manner of conducting the Department. This also pertains to all other classes of work.

A daily report is received from every job, although in somewhat different forms, but are finally worked down to segregation sheets for immediate presentation of the facts concerning the work.

COST OF DREDGING BY THE DEPARTMENT.

The river work of the Department has largely differentiated from former work of this class, but in comparison there is one item presenting figures the value and economy of which may be seen at a glance:

Dredging:

San Joaquin River cut-offs Nos. 3 and 4, 1898, cost per cubic yard, $0.12½.
Sacramento Snaggy Bend cut-off, 1900, cost per cubic yard, $0.15.
Cache Slough cut-off, 1901, cost per cubic yard, $0.94.
Diverting canal, Stockton (Government), 1908, cost per cubic yard, $0.14, about.

Dredging by Department of Engineering:

Kripp break fill, 1907, cost per cubic yard, $0.05½.
San Rafael Creek, 1908, cost per cubic yard, $0.0589.
Yuba River cut-off, 1908, cost per cubic yard, $0.0785.

Some instances exist where certain materials are more difficult of handling and therefore more expensive, or again, materials may through necessity, by clam-shell dredge, be handled twice. However, the suction dredge can in many instances obviate two handlings.

SUMMARY OF RIVER WORK.

Levee and Bank Protection.

Locality and Nature of Work	Square Yards Mattress.	Estimated Cost.	Contract Price.	Actual Cost.
*Rocky point, Revetment	1,840	$3,502 00	Cost and 10%	$4.879 61
*Kripp break revetment	3,400	2,250 00	Cost and 10%	2,773 90
*Kripp break, levee (102,489 cubic yards)		5,250 00	Day's labor.	5,674 30
*Brannan Island, revetment	21,892	18,998 00	Cost and 8%	22,081 38
†Sherman Island Revetment	4,400	6,325 00	Cost and 8%	4,391 42
†Merkeley Ranch revetment	3,440	6,513 00	Cost and 8%	5,177 10

Miscellaneous

Locality and Nature of Work.	Estimated Cost.	Contract Price.	Actual Cost.
‡San Rafael Creek, dredging	$9,450 00	$7,951 00	$10,589 00
Tisdale weir, temporary repairs		Day's labor.	678 68
Tisdale weir, permanent repairs	500 00	Cost and 10%	560 00
Tisdale weir, additions	11,018 00	$11,102 50	10,572 33
Yuba River cut-off, clearing		Day's labor.	1,604 50
Yuba River cut-off, excavation		Cost and 10%	2 829 83
Yuba River cut-off, dredging	10,500 00	$11,775 00	
Shanghai Bend cut-off, balance on clearing			345 05

* Work extended beyond original plans.
† Work curtailed from original plans.
‡ Original contract was for 7,000 lineal feet of channel, afterward extended to 9,500 feet.

SEGREGATION OF COSTS.

Revetment at Brannan Island; a mattress of willow brush in three sections, 2,620 feet, 187 feet, and 175 feet, respectively; total length, 2,982 feet; average width, 66½ feet; average thickness, 14 inches. Superficial area, 21,892 square yards. Cubic contents, 8,586 cubic yards. This mattress was built from a barge, in sections 225 feet in length, the upstream sections overlapping on the previously laid section downstream. Concrete used, 700 cubic yards.

Item.	Unit Cost of Concrete.		Item.	Unit Cost of Revetment.	
	Total Cost.	Cost per Cu. Yd.		Total Cost.	Cost per Sq. Yd.
Labor	$1,287 01	$1.830	Grading	$229 59	$0.010
Cement	1,161 29	1.659	Labor	1,411 33	0.064
Gravel	864 35	1.235	Brush	6,440 51	0.293
Lumber and nails	374 91	0.535	Cable and clips	5,727 24	0.262
Equipment	1,198 25	1.711	Equipment	1,281 32	0.056
Inspection	262 42	0.375	Concrete	5,531 09	0.252
Commission	382 86	0.547	Inspection	262 41	0.012
			Commission	1,197 89	0.055
Total	$5,531 09	$7.901	Total	$22,081 38	$1.004

Revetment on Sherman Island: a mattress of willow brush, 176 feet and 352 feet in length, respectively; total length, 528 feet; average width. 75 feet; average thickness, 16 inches. Superficial area, 4,400 square yards. Cubic contents, 1,984 cubic yards. Concrete used, 182 cubic yards. Method of construction, same as at Brannan Island.

Item.	Unit Cost of Concrete.		Item.	Unit Cost of Revetment.	
	Total Cost.	Cost per Cu. Yd.		Total Cost.	Cost per Sq. Yd.
Labor	$311 26	$1.729	Grading	$75 00	$0.017
Cement	305 64	1.695	Labor	224 70	0.051
Gravel	218 00	1.211	Brush	1,488 70	0.338
Lumber, etc.	84 07	0.466	Cable and clips	903 94	0.205
Equipment	201 22	1.118	Equipment	96 10	0.022
Inspection	103 56	0.575	Concrete	1,313 35	0.301
Commission	89 60	0.498	Inspection	74 20	0.017
			Commission	215 40	0.049
Total	$1,313 35	$7.292	Total	$4,391 39	$1.000

Revetment at Merkeleys: a mattress of willow brush in 4 sections, aggregating 774 feet; average width, 40 feet; average thickness, 20 inches. Superficial area, 3,440 square yards. Cubic contents, 1,912 cubic yards. Concrete, 145 cubic yards. Method of construction, same as at Brannan Island.

Item.	Unit Cost of Concrete.		Item.	Unit Cost of Revetment.	
	Total Cost.	Cost per Cu. Yd.		Total Cost.	Cost per Sq. Yd.
Labor	$332 17	$2.296	Labor	$246 01	$0.0715
Cement	289 58	1.997	Brush	1,434 39	0.416
Rock	243 61	1.681	Cable and clips	1,025 41	0.2925
Lumber, etc.	213 75	1.474	Equipment	196 50	0.0572
Equipment	196 75	1.357	Concrete	1,423 61	0.4145
Inspection	46 75	0.322	Inspection	50 06	0.0146
Commission	101 00	0.698	Commission	299 00	0.0872.
Total	$1,423 61	$9.825	Total	$5,177 10	$1.501

Kripp break, levee, and revetment: Levee, 1,600 feet long, 24 feet high, averaging 30 feet on top and containing 102,489 cubic yards. Revetment, a mattress of willow brush 710 feet long, 40 feet wide, 12 inches thick. Superficial area, 3,400 square yards. Cubic contents of mattress, 1,172 cubic yards. Mattress made on the bank and in place. Concrete used, 100 cubic yards.

Unit cost of levee: Total cost $5,667.64; cost per cubic yard, $0.0553.

Item.	Unit Cost of Concrete.		Item.	Unit Cost of Mattress.	
	Total Cost.	Cost per Cu. Yd.		Total Cost.	Cost per Sq. Yd.
Labor	$247 06	$2.47	Labor	$147 18	$0.042
Cement	163 79	1.64	Brush	921 05	0.272
Gravel	135 00	1.35	Cable and clips	548 92	0.162
Lumber	41 53	0.41	Concrete	824 32	0.269
Equipment	139 28	1.39	Inspection	148 00	0.044
Inspection	25 00	0 25	Commission	184 48	0.054
Commission	72 66	0.73	Total	$2,773 95	$0.843
Total	$824 32	$8.24			

Tisdale weir: construction of water cushion, 1,150 feet long, 12 feet deep, and 12 feet wide, with a lip 3 feet high. Total amount of concrete, 967.75 cubic yards. Total amount of steel, 61,549 pounds.

Item.	Unit Cost of Concrete.	
	Total Cost.	Cost per Cu. Yd.
For work	$916 63	$0.940
Form material	640 78	0 660
Steel work	327 06	0 385
Steel material	1,617 41	1,660
Mixing and placing	1,093 90	1.115
Cement	2,951 64	3.040
Gravel	1,600 30	1.650
Total	$9,147.72	$9.450

MISCELLANEOUS UNIT COSTS.

Yuba Cut-off: clearing right of way; 48 acres cleared at a cost of $1,604.55, or $33.429 per acre. Yuba Cut-off: channel excavated by scrapers, from Yuba River to the Western Pacific bridge; 21,620 cubic yards excavated; cost, $2,829.23, or $0.13 per cubic yard.

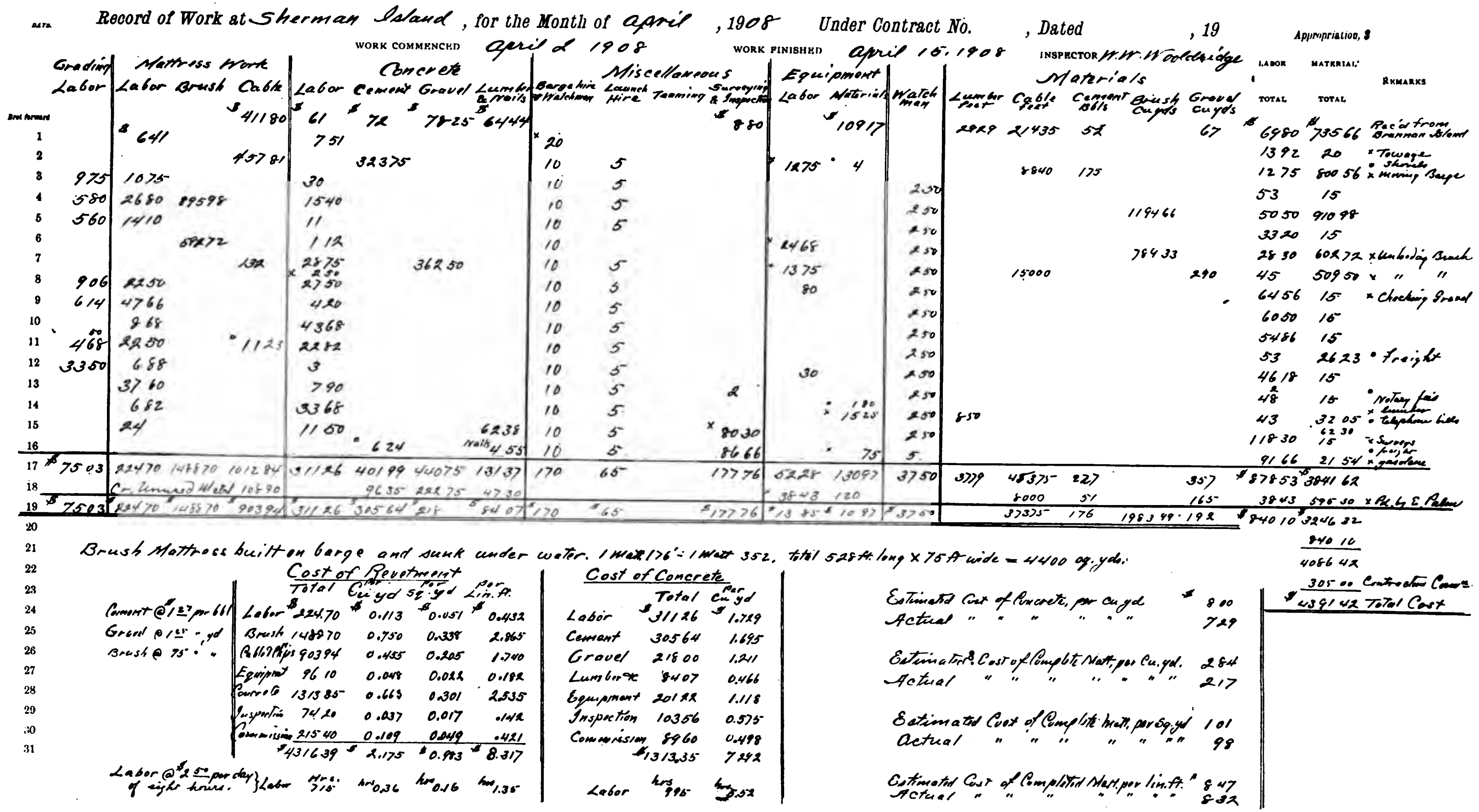
Survey of the Mokelumne River: 20.63 miles of traverse run; cost per mile, $16.10; 17.58 miles of levels run; cost per mile, $9.54; 12.52 miles of meander lines run; cost per mile, $11.

Office work and platting cost $270.00.

SAN FRANCISCO HARBOR FRONT.

The great amount of engineering work devolving upon the department on the San Francisco harbor front has been successfully and ably carried on by my assistant Mr. R. Barker. I have, however, personally viewed the work, and after January, 1909, expect to give my personal attention to this very important work in an endeavor to get the best engineering results possible. The architectural changes to the Ferry building are given in the tables for such work, except the new candy booth built and paid for by Foster & O'Rear after the design by this office. I shall therefore confine myself strictly to the engineering work at this point in the report.

East street, San Francisco, being under the control of the State Board of Harbor Commissioners, brings under their control on the harbor front the additional work of paving. This is an important part of the State work on account of the great amount of heavy draying and teaming over it. To date, it consists principally of basaltic blocks laid on an earth or sand fill. On account of the manner or mode of construction, the seawall, which is porous, permits the action of the tides to gradually work away the street fill and therefore undermine the foundation to the paving blocks. For this reason it was decided to not use a concrete foundation for the paving blocks, as it might in places be left suspended or crush down after a few years. In this connection it is proper to look at the class of seawall the State is constructing on the harbor front. In the first place, the mud is dredged out and a trench is made to receive the material of which the wall is to be constructed. Broken rock is transported to the place and dumped into the trench, the rock is brought up to the required height and finished by laying a hand course of rubble. The larger stones are somewhat segregated and used for facings. This constitutes a seawall. After carefully considering the matter, it is thought and recommended that this class of construction should be abandoned and a substantial hollow rein-



Record of Work at Sherman Island, for the Month of April, 1908 Under Contract No. , Dated , 19 Appropriation, $

WORK COMMENCED April 2 1908 WORK FINISHED April 15. 1908 INSPECTOR W. W. Wooldridge

DATE	Grading	Mattress Work			Concrete				Miscellaneous				Equipment			Materials					LABOR	MATERIAL	REMARKS
	Labor	Labor	Brush	Cable	Labor	Cement	Gravel	Lumber & Nails	Barge hire & Watchman	Launch Hire	Teaming	Surveying & Inspection	Labor	Material	Watchman	Lumber feet	Cable feet	Cement Bbls	Brush Cu yds	Gravel Cu yds	TOTAL	TOTAL	
Brot forward				$ 41180	$ 61	$ 72	$ 7825	$ 6444				$ 880		$ 10917		2929	21435	52		67	$ 6980	$ 73566	Rec'd from Brannan Island
1		$ 641			751				× 20												1392	20	× Towage
2				45781		32375			10	5			× 1275	° 4			8840	175			1275	800 56	° Shovels × Moving Barge
3	975	1075			30				10	5					250						53	15	
4	580	2680	89598		1540				10	5					250				119466		5050	91098	
5	560	1410			11				10	5					250						3320	15	
6			59272		1 12				10				× 2468		250				78433		2830	60272	× Unloading Brush
7				132	2875		36250		10	5			× 1375		250		15000			240	45	50950	× " "
8	906	2250			× 250 2750				10	5			80		250						6456	15	× Checking Gravel
9	614	4766			420				10	5					250						6050	15	
10		968			4368				10	5					250						5486	15	
11	$\overset{50}{468}$	2250		° 1123	2282				10	5					250						53	2623	° Freight
12	3350	688			3				10	5			30		250						4618	15	
13		3760			790				10	5		2			250						$\overset{2}{48}$	15	° Notary fees
14		682			3368				10	5				° 180 × 1525	250	850					43	32 05	× Lumber ° Telephone bills
15		24			1150			6238	10	5		× 8030			250						11830	62 30 15	× Surveys
16						° 624		Nails 4 55	10	5		8666		° 75	5.						9166	21 54	° freight × gasolene
17	$ 7503	22470	148870	101284	31126	40199	44075	13137	170	65		17776	6228	13097	3750	3779	45375	227		357	$ 87853	$ 384162	
18		Cr. Unused Mat'l		10890		9635	22275	4730					× 3843	120			8000	51		165	3843	59650	× Pd. by E. Palm
19	$ 7503	$ 22470	$ 148870	$ 90394	$ 31126	$ 30564	$ 218	$ 8407	$ 170	$ 65		$ 17776	$ 13 85	$ 10 97	$ 3750		37375	176	198349	192	$ 84010	$ 324632	

84010

4086 42

305 00 Contractors Comm.

$ 4391 42 Total Cost

Brush Mattress built on barge and sunk under water. 1 Matt 176' - 1 Matt 352. total 528 ft. long × 75 ft wide = 4400 sq. yds.

Cement @ $1 27 per bbl
Gravel @ 1 25 " yd
Brush @ 75 " "

Cost of Revetment

	Total	per Cu yd	per Sq yd	per Lin. ft.
Labor	$ 224.70	$ 0.113	$ 0.051	$ 0.432
Brush	1488 70	0.750	0.338	2.865
Cable & Clips	903 94	0.455	0.205	1.740
Equipment	96 10	0.048	0.022	0.182
Concrete	1313 85	0.663	0.301	2.535
Inspection	74 20	0.037	0.017	.142
Commission	215 40	0.109	0.049	.421
	$ 4316 39	$ 2.175	$ 0.983	$ 8.317
Labor	Hrs. 715	hrs 0.36	hrs 0.16	hrs 1.35

Labor @ $2 50 per day of eight hours.

Cost of Concrete

	Total	per Cu yd
Labor	$ 311 26	$ 1.729
Cement	305 64	1.695
Gravel	218 00	1.211
Lumber &c	84 07	0.466
Equipment	201 22	1.118
Inspection	103 56	0.575
Commission	89 60	0.498
	$ 1313.35	7 292
Labor	hrs 995	hrs 5.52

Estimated Cost of Concrete, per cu yd	$ 8 00
Actual " " " " " "	7 29
Estimated Cost of Complete Matt, per Cu. yd.	2 84
Actual " " " " " " "	2 17
Estimated Cost of Complete Matt, per Sq yd	1 01
Actual " " " " " " "	98
Estimated Cost of Completed Matt, per lin. ft.	$ 8 47
Actual " " " " " " "	8 32

PHOTOGRAPH OF SEGREGATION SHEET RIVER WORK.

forced concrete construction either resting on piles or hardpan be devised and designed to continue any further work on the seawall. To be sure it will cost perhaps twice as much as the present method of work, but its stability and permanency will be worth every cent of the extra cost.

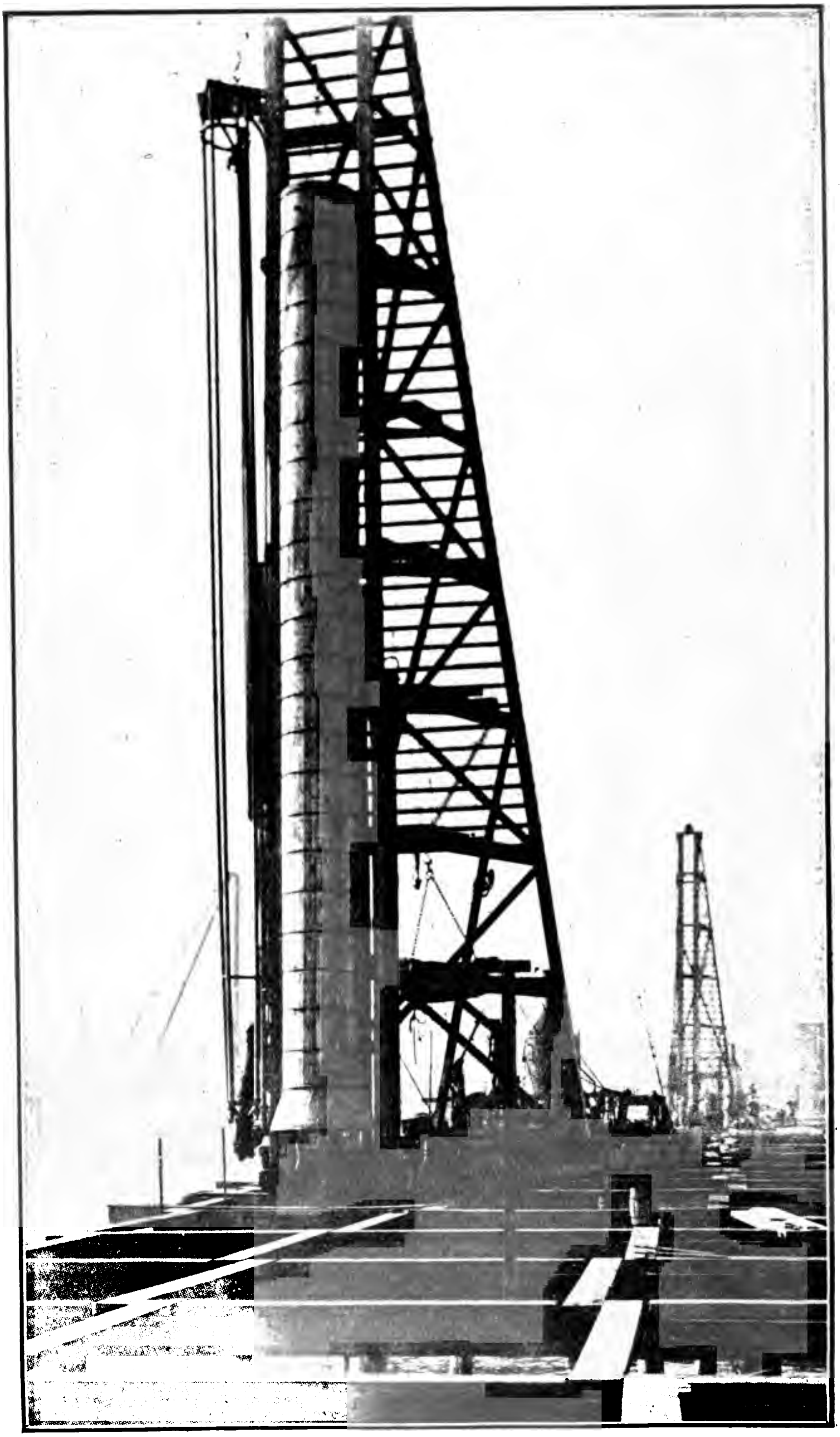
The construction of the piers is of great importance to the State and San Francisco, and should be done with the greatest care and economy. No effort should be spared to have the docks of San Francisco among the best, and I earnestly believe the State should construct this work so far as possible of concrete or masonry. The two new piers, Nos. 38 and 40, are to be of reinforced concrete in their entirety, and should prove an excellent class of construction. Steel should never be exposed to the salt water and air, as are the I beams in the new Pacific mail dock. Upon examination of the beams carrying the wharf proper, I found that the web of the metal would flake off at least 25 per cent. To prevent this they must be kept thoroughly painted, or else shortly new beams will be required. If these beams had been imbedded in concrete this rusting could have been obviated. The greatest care must be exercised in the foundation work along the water front, or else the construction may prove valueless. The one great point of dock work is to have the submarine part done thoroughly and without the sole thought of trying to get it done cheaply. Cheap construction and poor inspection is the cause of a heavy cost of maintenance. No matter what the State undertakes, there is always a tendency to cheaply build. Appropriation bills are often placed above the needs, then trimmed down to fit what is thought right. We should have an estimate for first-class work at a reasonable price and adhere to it. The most unwise economy the State tolerates is the cheap substructure work on the great water front at San Francisco. I would recommend a good substantial seawall to be practically indestructible, and docks and piers in keeping therewith. We can not accomplish this at once, but we can adopt such a plan and work to it. When funds are available, only permit them to be expended in first-class construction. Finally, as we go along with this scheme, the State will begin to cut off some of the very great maintenance expense. At some future time we must adopt this plan, and it is my opinion that no better time exists than now.

The new piers, Nos. 38 and 40, are 130 feet wide and 657 and 650 feet long, respectively. They when built will represent the initial construction along a permanent plan. The great amount of work at this State institution would require a very considerable space to give any detail. Therefore, the following table gives the work accomplished and under construction from May, 1907, to December 1, 1908. The mass of details and reports are filed in the department and open to inspection.

WORK ACCOMPLISHED AND UNDER CONSTRUCTION FROM MAY, 1907, TO DECEMBER 1, 1908.

	No. of Bids.	High Bid.	Low Bid.	Estimate.	Contract or Cost.	Date of Bids.
Paving.						
East street, vicinity of Piers 42 and 44—99,000 sq. ft., 1,880 ft. curb, etc.	9	$31,179 00	$28,821 00	$30,500 00	$28,821 00	Aug. 27, 1908
East street, between Kearny and Francisco—25,151 square feet paving, 2,176 square feet repaving at 10 cents	4	9,531 80	7,075 40		8,366 52	April 4, 1907
East street, between Lombard and Vallejo—22,000 feet new paving, 3,000 square feet repaving	5	8,240 00	6,652 50	6,600 00	6,652 50	Sept. 19, 1907
Extension, repaving 47,881					3,799 53	
East street, between Francisco and North Point—35,000 feet new paving, 32,500 repaving, etc.	2	14,965 00	14,906 25		14,906 25	Oct. 3, 1907
East street, bet. Kearny and Taylor—146,000 square feet paving, etc	3	58,045 00	52,449 00	48,000 00	52,449 00	Oct. 31, 1907
East street, between Market and Folsom—90,000 square feet repaving, 2,500 feet curbing, etc.	3	14,425 00	12,625 00	15,000 00	12,625 00	Nov. 7, 1907
Center street, east of Illinois—22,250 square ft. paving, 610 ft. curbing	4	8,986 00	7,303 00	7,000 00	7,303 00	Nov. 7, 1907
Crossing of Sansome and Chestnut—2,000 feet new paving, 3,000 feet repaving, etc.	3	915 00	893 00		893 00	Mar. 5, 1908
East street, between Clay and Washington—31,926 feet paved, 536 feet curb reset, 5 cesspools					2,937 20	April 20, 1908
East street, between Washington and Vallejo—120,000 feet paving, 40,000 feet repairing, 1,300 feet curb, etc.	5	30,015 00	21,722 00	23,000 00	21,722 00	July 9, 1908
Crossing on East street, Market and Clay	3	14.8c	7¼c		7¼c	Sept. 17, 1908
Bulkhead north of Wharfinger's office, asphalt					661 05	
Wiring tower					725 00	Mar. 23, 1908
Free Market, lot No. 16 seawall	18	9,294 00	5,476 00	6,000 00	5,476 00	Dec. 12, 1907
Wharves.						
Central Basin, 2 wharves Loop Lumber Co., wooden, 106,720 sq. ft.	7	64,760 00	44,760 00		44,760 00	May 23, 1907
Along Stewart street, repairs				Cost.	4,792 00	July 29, 1907
Pier 12 to Pier 14	6	2,967 25	2,380 00		2,380 00	
Bulkhead (reinforced concrete), Pier 19 to Pier 21		Day's labor.			17,559 06	Oct. 1, 1907
Asphalt wearing surface					1,263 49	
Bulkhead north of Wharfinger's office, 7,770 square feet		Day's labor.			4,836 81	Oct. 1, 1907
Central Basin, wooden, Union Oil Co., 6,437 square feet	8	4,797 00	3,911 00		3,911 00	Oct. 10, 1907
Illinois street, 17th to 18th streets	11	70,799 00	56,786 00		56,786 00	Nov. 29, 1907
Central Basin, wooden, Loop Lumber Co. to dry dock	8	2,500 00	1,577 00		1,577 00	Feb. 6, 1908
Bulkhead, wooden, section 12 of seawall, 30,000 square feet	7	3,942 00	1,600 00	2,000 00	1,600 00	Jan. 23, 1908
Section 12 of seawall	6	1,882 00	849 00		849 00	Feb. 28, 1908
Fisherman's concrete covering, studded piles, 1,500 feet	4	2,506 00	1,467 72		1,467 72	July 30, 1908
Bulkhead, section 12, seawall, steel and concrete, 37,860 square feet	6	76,300 00	64,500 00		64,500 00	Sept. 17, 1908
Pier No. 10, 2 chutes, wooden	5	398 00	287 00	260 00	287 00	Nov. 5, 1908
Illinois street, south of Santa Clara—153,148 square feet	8	93,700 00	57,741 00		57,741 00	Nov. 10, 1908

Piers.						
Pier No. 27, 541 by 120 feet	6	139,000 00	129,800 00		129,800 00	April 12, 1906
Pier No. 27, extension, 60 by 120 feet					19,750 00	
Pier No. 40, 650 by 130 feet	7	423,057 00	302,400 00	375,000 00	302,400 00	June 22, 1908
Pier No. 38, 667 by 130 feet	11	357,500 00	279,000 00	350,000 00	279,000 00	Oct. 8, 1908
Sheds.						
On sections 1 and 2 of seawall, wooden, 80 by 400 feet					15,240 00	
On section 2 of seawall, wooden, 80 by 400 feet	11	27,300 00	11,993 00	11,600 00	11,993 00	July 18, 1907
On section 2 of seawall, wooden, 80 by 200 feet					5,997 50	
On Pier No. 27, wooden, 100 by 572 feet	12	28,800 00	22,475 00	26,000 00	22,475 00	Sept. 26, 1907
On Pier No. 1, wooden extension	5	1,450 00	1,225 00	1,250 00	1,225 00	Dec. 17, 1907
On Pier No. 3, wooden, 40 by 192 feet	8	1,529 50	1,132 00	1,300 00	1,132 00	Dec. 18, 1907
On seawall, lot No. 11, wooden, 37 by 87.5				3,000 00	2,905 00	April 16, 1908
On Pier No. 3, wooden, 71 feet 8 inches by 430 inches	5	5,537 00	4,700 00	4,200 00	4,700 00	July 9, 1908
Seawall.						
Section No. 12, 1,000 feet, 124,898 tons of rock	4	202,500 00	118,350 00	Cost.	97,249 95	June 13, 1908
Fisherman's Wharf	3	925 89	789 02		789 02	June 11, 1908
Section No. 12, cross embankment, 11,069 tons of rock	3	5,061 07	3,754 77		3,754 77	July 30, 1908
Section No. 11, 600 feet, 85,000 tons of rock	5	103,150 00	59,075 00	72,000 00	59,075 00	Nov. 19, 1908
Tugs and Dredges.						
Clam-shell bucket					1,300 00	Mar. 5, 1908
Fuel burners	4	1,044 31	395 00	500 00	395 00	Feb. 13, 1908
Electric lights for Governors Markham and Irwin	4	3,488 00	2,750 00	2,920 00	2,750 00	July 9, 1908
Electric light plant, Dredge No. 3	4	1,631 00	1,245 00	1,360 00	1,245 00	July 9, 1908
Winding drums, Dredge No. 2	7	955 00	779 00		779 00	May 8, 1908
Tubular boiler, Dredge No. 2				3,150 00	2,675 00	Aug. 8, 1907
Repairs to engine, Governor Irwin					1,575 00	July 2, 1908
Belt Railway.						
Roundhouse roof, corrugated iron	4	1,054 00		400 00	645 00	July 9, 1908
Oil tanks, reinforced concrete		Day's labor.		3,000 00	3,790 51	
Replacing T rail with girder rail				7,000 00	8,043 40	Nov. 29, 1907
Miscellaneous.						
Dredging Channel street				30,000 00	27,250 00	
Purchase of old lumber, per M					2 25	
Repairs to shingle roofs of sheds					3,514 49	
Lumber for general repairs, per M	8	20 00	15 75		15 75	Oct. 10, 1907
Cleaning East street, per M yards					80	June 2, 1908
Cleaning East street, per M yards, District No. 5					1 00	June 2, 1908
2 landing floats					2,296 00	



CYLINDER FOR THE NEW PIER 40, SAN FRANCISCO HARBOR FRONT.

CALIFORNIA ROADS.

At the last session of the legislature there was passed an act, known as the Savage Road Law, permitting counties to bond their whole property for road improvement purposes. It extended the supervisorial powers so that cities and municipalities may pay part of the expense of good country roads.

This is considered a step in advance, and those who have watched road legislation, and the results thereof, have contended for such enactment as a proper means for obtaining the necessary funds to make good roads possible. Aside from obtaining the funds for this improvement there are several very important factors involved in the road problem which must be taken cognizance of if we expect to advance to the position of our Eastern States.

We must obtain legislation of a character that will put road affairs on a systematic business footing. The State's great need is system injected into the management of and expenditures on our roads.

Centralize the road management power sufficiently to overcome the local influences, put well-paid, technical men in charge of technical work, and create a proper system of maintenance.

Those who have just casually viewed our present method of road work note the great measure of failure.

The county roads are handled, not by trained men, but by those who profess to know all about the construction and maintenance of roads. That the task is one of difficulty can not be denied. Even the engineer must be specially trained and experienced in this work if he expects to be successful. We need more substantial training for our road foremen and engineers. We need to impress them with the necessity of following scientific construction and maintenance, to take interest in their work and properly safeguard the maintenance expenditures. There is no greater economic problem presented to our State than the proper administration of our road business.

An approximate mileage of 50,000 and expenditure of $3,500,000 per annum for maintenance thereof, indicates the magnitude of this part of our public work. For years we have been expending between $2,000,000 and $3,500,000, practically all on maintenance, but have not attained the results sought. There must be some mistake or trouble. Consider our experience with oiled roads. For several years we have been applying oil on the roads with but little good effect, when if properly used, our State could make the finest highways in the world. The materials abound, and yet we do not take advantage of them. Other states of this Union, and especially those of the East and Middle West, would highly prize the native road materials of California.

Could the money expended on county roads for the past fifteen years have been applied to the construction of good rock roads, a system of highways could have been established and built connecting every county seat in the State. Had these same roads been given the same maintenance the county roads now get, in a very few years the deterioration would have been so great as to discourage those advocates who look at the subject but superficially. The great problem with the Savage road law is that no provision is made for maintenance. No matter how well we build our roads, they must be thoroughly and properly maintained if we are to receive the benefits accruing from good roads. Think of some road you believed, at the time, was well built, then remind yourself of its bad condition about four or five years thereafter. Numerous examples of this kind exist, and yet we persist in going ahead with the same unsystematic maintenance that prevailed twenty-five years ago.

Several counties are now bonded, or are about to bond, for road construction, but not one dollar for maintenance. I would advise a careful study of the problem, that the best results may be obtained.

Ask yourself how the work will be carried on, then investigate the laws inaugurated by other states in their endeavor to meet the same conditions, the same failure and troubles we have had.

The Aid scheme is not new or untried, but has proven most efficacious in a great many Eastern States. New Jersey was the pioneer to embrace state aid sixteen years ago, and continues to expend large appropriations through this method. A great many other states went through our experience and upon the adoption of the aid plan, placed their roads on a better business basis, brought the construction and maintenance under trained men, gave the counties uniformity in plans, disposed of the local influences, began an era of road education, and brought the maintenance to an efficient standard.

It is advocated by many that aid should be extended to the counties for maintenance and not for construction, and that the county engineers, or some one man, be appointed, or elected, to control the work on the county roads.

Carefully read what other aid law states have done, and note their success. It appears to me that we are, at present, so far behind the progressive states in road legislation that we can well afford to pattern after laws which have now stood the test for fifteen to sixteen years.

Should California begin with paying the maintenance and supervise the construction, or should we supervise the maintenance, and aid in the construction, as the aid states, with the exception of Massachusetts, do. An additional plan of assistance may be advanced whereby the State obtain and declare for a system of state roads, paying for their cost and maintenance, thus entirely controlling them as state institutions.

The people of New York have added to their aid law and now have by statute, outlined a system of state trunk roads to be entirely handled by the state. The aid law will operate to assist the localities beyond the trunk lines.

Pennsylvania is urged to adopt the same plan and the reasons therefor are aptly stated. "There are two fundamental policies which must be reckoned with. First, there must be a plan that is reliable in every respect which must be settled upon and then stuck to; second, and more important than the plan, the roads, when built, must have a system of maintenance and repair that will work. Not one cent of money should be expended in the cause of good roads until there be some provision made for a systematic plan, and also provision made for first class maintenance of the roads when built." This is the keynote to the problem.

After a study of California roads for eight years, I feel disposed to offer and recommend a law similar to that of the State of New York, and earnestly believe its enactment would prove of inestimable value. Should the State desire to enter into the scheme of a system of State highways, then the aid law could only be considered secondarily.

STATE-AID ROAD LAW.

AN ACT TO PROVIDE FOR THE IMPROVEMENT OF THE PUBLIC HIGHWAYS, AND TO MAKE AN APPROPRIATION THEREFOR.

The people of the State of California, represented in senate and assembly, do enact as follows:

SECTION 1. The board of supervisors in any county of the State may, and upon presentation of a petition as provided in section two hereof, must pass a resolution that public interest demands the improvement of any public highway, or section thereof, situate within such county, and described in such resolution; but such description shall not include any portion of a highway within the boundaries of any city or incorporated village; and within ten days after the passage of such a resolution shall transmit a certified copy thereof to the State Department of Engineering.

SEC. 2. The owners of two thirds of the lineal feet fronting on any such public highway or section thereof in any county of the State may present to the board of supervisors of such county a petition, setting forth that the petitioners are such owners, and that they desire such highway or section thereof be improved under the provisions of this act.

SEC. 3. The Department of Engineering, upon receipt of such resolution, shall investigate and determine whether the highway or section thereof sought to be improved is of sufficient public importance to come within the purposes of this act, taking into account the use, location, and value of such highway or section thereof for the purposes of common traffic and travel, and after such investigation shall certify its approval or disapproval of such resolution. If it shall disapprove such resolution, it shall certify its reasons therefor to such board of supervisors.

SEC. 4. If such resolution shall be approved, such Department of Engineering shall cause the highway or section thereof therein described to be mapped, both in outline and profile. The said Department shall indicate how much of such highway or section thereof may be improved by deviation from the existing lines whenever it shall be deemed of advantage to obtain a shorter or more direct road without lessening its usefulness, or whenever such deviation is of advantage by reason of lessened gradients. The said department shall also cause plans and specifications of such highways or section thereof, to be thus improved to be made for telford, macadam, or gravel roadway or other suitable construction, taking into consideration climate, soil, and materials to be had in the vicinity thereof, and the extent and nature of the traffic likely to be upon such highway, specifying in its judgment, the kind of road a wise economy demands. The improved or permanent roadway of all highways so improved shall not be less than eight feet in width, unless for special reasons to be stated by such Department of Engineering it is required that it shall be a width of certain dimensions.

SEC. 5. Upon the completion of such maps, plans, and specifications, such Department of Engineering shall cause an estimate to be made of the cost of construction of the same and transmit the same to the board of supervisors from which such resolution proceeded, together with a certified copy of such maps, plans, specifications, and of a certificate of the approval of the highway or section thereof so designated as aforesaid.

SEC. 6. After the receipt thereof, upon a majority vote of such board of supervisors, it may adopt a resolution that such highway or section thereof so approved, shall be constructed under the provisions of this act, or of any existing act, and thereupon shall transmit a certified copy of such resolution to such Department of Engineering.

SEC. 7. In case the boundaries of such proposed highway shall deviate from the existing highway, the board of supervisors must make provisions for securing the requisite right of way prior to the actual commencement of the work of improvement.

SEC. 8. Upon receipt of the certified copy of the resolution provided in section six, such Department of Engineering shall advertise for bids once a week for four consecutive weeks in a newspaper published at the county seat of such county, and in one such other newspaper as shall be deemed of advantage for the construction of such highway or section thereof, according to such plans and specifications, and award such contract to the lowest responsible bidder, except that no contract shall be awarded at a greater sum than the estimate provided in section five. But if no bid otherwise acceptable be made within such estimate, such Department of Engineering may amend the estimate, certify the same to the board of supervisors, and upon the adoption by it of a resolution as provided in section six, based on such amended estimate, proceed anew to obtain bids and award the contract as herein provided. Such Department of Engineering may reject any or all bids and may as an alternative plan, upon the approval of the full advisory board of the department, do the work under the full control of such department, upon a day's labor basis; *provided*, the board of supervisors of the county in which the work is proposed, grant their consent thereto by a resolution of said board. Before entering into any contract for such construction shall require a bond, with sufficient sureties, conditioned that if the proposal shall be accepted, the party thereto will perform the work upon the terms proposed and within the time prescribed and in accordance with the plans and specifications; and as a bond of indemnity against any direct or indirect damages that shall be suffered or claimed during the construction of such road, and until the same is accepted. The people of the State of California shall in no case be liable for any damages suffered. Partial payments may be provided for in the contract, and paid in the manner herein provided, when certified to by such Department of Engineering, to an amount not to exceed seventy-five per cent of the value of the work done; twenty-five per cent of the contract price shall be retained until the entire work has been accepted. Whenever a county engineer or surveyor has been appointed or elected in the county in which such highway or section thereof is to be constructed, he shall have general charge and supervision of the work under the control of the Department of Engineering, and shall report to said department from time to time the progress of the work and such facts in relation thereto as may be required. If there is no county engineer or surveyor, such Department of Engineering shall have some competent person to superintend and have engineering supervision of the work.

SEC. 9. Two fifths of the expense of the construction thereof shall be paid by the State Treasurer upon the warrant of the Controller, issued upon the requisition of such Department of Engineering, out of any specific appropriations made to carry out the provisions of this act. And three fifths of the expense thereof shall be a county charge in the first instance, and the same shall be paid by the county treasurer of the county in which such highway or section thereof is, upon the requisition of such engineer or surveyor; but the amounts so paid shall be apportioned by the board of supervisors, so that if the same has been built upon a resolution of said board without petition, forty per cent of the cost of construction shall be a general county charge, and twenty per cent shall be a charge upon the road district in which the improved highway or section thereof is located, and if the same has been built upon a resolution of said board after petition as provided in section two, forty per cent shall be a general county charge and twenty per cent shall be assessed upon and paid by the owners of the lands benefited in the proportion of the benefits accruing to said owners as determined by the county assessor in the next section hereof.

SEC. 10. The assessor of the county in which any highway or section thereof has been improved or constructed pursuant to petition, as provided in section two of this act, shall have power, and it shall be his duty upon receiving notice from the board of supervisors of the county of the cost of construction or improvement of such highway or section thereof in such road district, to assess an amount equal to twenty per cent of said total cost upon the lands fronting or abutting on such highway or section thereof. Such assessment shall be apportioned according to the benefits accruing to the owners of the lands so located, according to the best judgment of said assessor, upon at least ten days' notice of the time and place of such apportionment to the persons affected thereby, and after such persons have had an opportunity to be heard, and the assessments so made when duly attested by the oath of such assessor shall be collected in the same manner as the general taxes of such county are collected.

SEC. 11. The construction and improvement of highways and sections thereof, under the provisions of this act, shall be taken up and carried forward in the order in which they are finally designated, as determined by the date of the receipt in each case of the certified copy of the resolution provided in section six by such Department of Engineering as hereinbefore provided.

SEC. 12. Upon the completion of such highways or sections thereof so constructed by such Department of Engineering and its acceptance of the same after payment has been made as herein provided, such Department of Engineering shall inform the board of supervisors of such counties that the highways or sections thereof designated have been constructed as herein provided; and he may serve notice on said board to accept such highway thus constructed, which notice shall be filed in the office of the clerk of such county; and twenty days after service and filing of said notice, such highway or section thereof shall be deemed accepted by said board of supervisors of said county; and thereafter they shall maintain the same as a county road and apportion the expense as they may be empowered by law. The county wherein such improved highways lie shall care for and keep the same in repair under the direction and supervision of the Department of Engineering and such rules and regulations as it may prescribe. Should the county fail to comply with said rules and regulations, then such Department of Engineering shall cause the maintenance work to be done, and the cost of the same shall be a county charge, paid for upon claims approved by the Department of Engineering, in the same manner as for other county roads.

SEC. 13. Whenever any county has had aid in building any such highway and it seems advantageous to such Department of Engineering that a section or sections of highway, not exceeding one mile in length, shall be constructed under this act to connect these roads together, and would be a great public utility and general convenience, notice may be served by said department on the board of supervisors of such county, and shall file one in the county clerk's office, designating the highway already constructed and the existing termini, and the section or sections, in his opinion, necessary to be constructed and the reasons therefor. And it shall be the duty of the board of supervisors to provide for the construction of such connecting highway or section thereof, within one year after the service and filing of such notice. The procedure for such work shall be in accordance with the provisions of this act.

SEC. 14. There is hereby appropriated out of any money in the state treasury not otherwise appropriated, the sum of one hundred and fifty thousand dollars to carry into effect the provisions of this act.

SEC. 15. The operation of this act shall not be affected by any conflicting act or conflicting part of any act wherever the same may now exist, and the highways may be improved under this act or any existing act relating to roads.

SEC. 16. This act shall take effect immediately.

The reader's attention is directed to a copy of the Savage law given in the appendices, as is also a table of costs of the county roads per annum, and a late specification of oiled macadam roads.

OIL FOR ROADS.

The subject of oiled roads has spread beyond the limits of the State and other states are going through several experimental stages of oiling highways. It has failed to attract attention longer, in California, and in passing over a great many pieces of oiled roads badly cut up or rutted, you always hear the driver condemn them. It is not the fault of the oil, but the application and maintenance. Many suppose the oil a panacea for road ills without further treatment. No more mistaken notion ever existed. Oiled roads must receive careful maintenance to be of economic value, and it is a positive setback to road business to allow the use of oil on roads to become so objectionable while yet so meritorious a material.

The use of the automobile, beyond doubt, wears a road faster than the vehicle hauled by animal power. The cloud of dust we have all seen after the passing of a swift moving automobile, surely gives evidence of the rapid wear caused by the machines. Again, macadam roads are much more quickly disintegrated when autos are used on them at high speed than by the older modes of travel. This change of vehicles has been so sudden as to allow no time to adjust the road building and repair. Our old way is now antiquated, and we must turn to new processes of work. Heavy asphaltic oil will meet the change. Applied properly, I earnestly believe we need have no fear of being able to cope with the destructive effect of machines on our highways. The oil will create a mass of material incapable of being sucked up by the flattened tires, and if made firm, which is proper, will not yield to pressure or tractive force. Good oil earth roads are still within our reach, and if we will put interest in our road work, as we should, and properly treat them then can the country roads be made so smooth, dustless, and mudless as to chagrin those who discountenance its use. Then have maintenance that is substantially good and they will remain in excellent condition. Gravel roads may be treated with heavy asphaltic oil with splendid effect.

The treatment of macadam with oil gives an almost ideal highway capable of withstanding much more severe usage than plain macadam. The asphalt of the oil acts as a binder to the particles of rock composing the body of a macadam road, gives it elasticity, and is a waterproof covering. In fact, it acts much as bituminous macadam, which makes an excellent road or even residential street for city use. The use of oil will not, however, be appreciated for road purposes until we obtain a systematic plan of construction and maintenance. Any one desiring information on the use of oil on roads may obtain the 1906 report on the subject, now in the possession of the Department of Engineering. Although two years old, this report presents the best method of oiling up to the present time.

PRESENT STATE ROADS.

The State roads now owned by California and under the control of this Department, all traverse the mountainous districts. No valley roads or macadam highways are under State supervision. To date, the policy of the State has been to construct and maintain roads through territory where construction is expensive and the counties through which they run are too poor to properly care for a road. In cases of this kind the assistance rendered by the State is proper and should be extended.

One may to-day attempt the trip of viewing the wonders of our mountains and find himself blocked by being unable to travel by road. The finest scenery of the Sierra Nevadas is inaccessible, and would, if opened by road, prove a valuable asset to the State.

THE LAKE TAHOE WAGON ROAD.

The importance of this road is steadily growing and its traffic is so rapidly increasing that its maintenance needs, in consequence of the extra wear, are much greater than any time during the past twenty years.

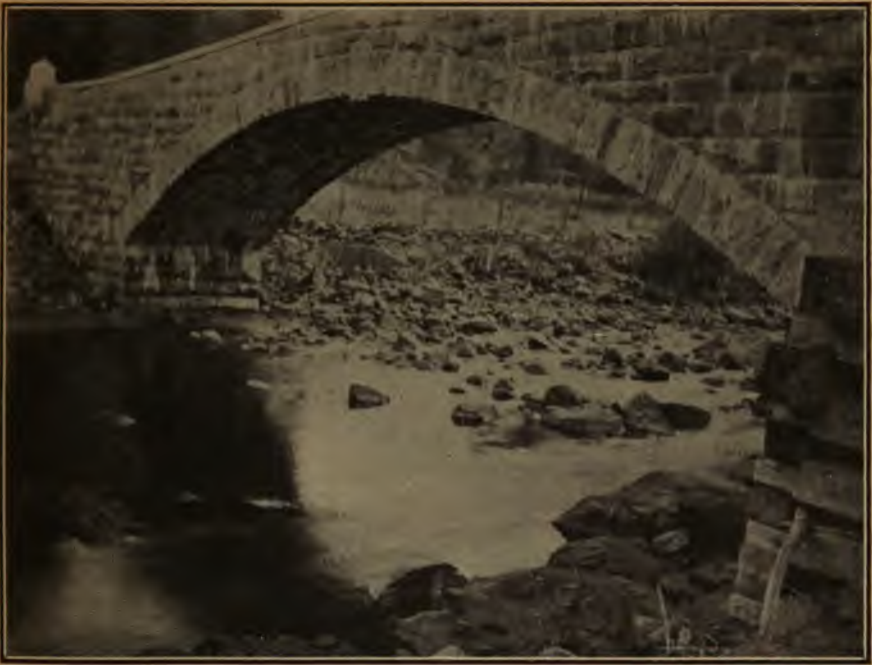
Heavy hauling over the first fourteen miles of this highway causes a deep light dust to accumulate during the summer months, and thereby makes traveling very disagreeable. With the increased use of automobiles and the great number of them traversing this State road, comes a demand for laying this dust and making a smoother surface.

The present maintenance fund of $5,000 per annum gives little or no money to be expended for the remedy of this bad feature. The original construction of this road used wooden culverts, brush fills, and wooden bridges, which necessarily have been giving out and so nearly at the same time as to almost deplete the maintenance fund for the purpose of replacing these structures with permanent ones. It should be the policy of the State to do this work in a permanent, substantial manner, so that eventually there will be no cost from this source. I have, therefore, made it the rule to replace these structures with stone, concrete or vitrified pipe, for culverts, as fast as they become unserviceable. This, with the fact that the lower twelve or fourteen miles of the road must be scraped and crowned each spring, keeps the funds too low to allow of any watering or oiling.

On November 1, 1908, this road possessed one hundred seventy-five vitrified pipe, stone, and concrete culverts, the concrete culvert or bridge at Oglesby Canyon, the cut ashlar granite bridge of eighty-one feet span over the American River at Riverton, and the rubble stone bridge of twenty-six feet span over Trout Creek. Permanent reconstruction work, to place the bridges and culverts in first class shape, would require about one hundred and fifty culverts with possibly twenty-five from the

TYPE OF ROAD FILL AND CULVERT ON LAKE TAHOE STATE ROAD BEING REPLACED BY THE DEPARTMENT.

NEW CULVERT AND FILL, LAKE TAHOE STATE ROAD.



CUT ASHLAR STONE BRIDGE, LAKE TAHOE STATE ROAD, 81-FOOT SPAN.

NEW STONE CULVERT, LAKE TAHOE STATE ROAD.

Summit to the Little Truckee River, seven bridges of twenty to thirty feet span and a bridge over the Little Truckee fifty feet in span.

However, the crossing last mentioned has a sufficiently good wooden structure for at least eight more years and the crossing of the South Fork of the American River near Strawberry is spanned by a wooden bridge of at least eight years' life.

The Oglesby Canyon bridge, contracted for to Mr. T. E. Clark of Sacramento for $846, was never satisfactorily completed by him, and in consequence, his cash bond of $100 was taken over by the State, and the work completed under the supervision of Mr. A. S. Lyon, the present superintendent of the road.

The Trout Creek bridge is built of squared rubble granite stone with both abutment foundations on bed rock, twenty-six feet span, and furnishes the State a valuable structure.

The legislature of 1907 appropriated $5,000 for the general improvement, the completion of the survey of the road, and the erection of milestones. Since 1901 milestones were cut for this road, but on account of the lack of a survey and therefore location, they remained unplaced, except those to the 25-mile post, at Riverton. After the appropriation, however, this Department began the survey July 23, 1907, and completed it August 30, 1907. Mr. George W. Kimble was in charge of the work and made a complete survey of the road from near the twenty-five milestone to the State line near Lake Tahoe. All topographical features were noted — creeks, culverts, grades, soils, and bridges. At every one thousand feet was established a concrete block as a monument showing the permanent location of the road, and establishing the right of way as shown by the main traveled part thereof. These monuments were set in the center of the road about eighteen inches below the surface and were witnessed by proper marks to readily determine their location. After the completion of this work Mr. A. S. Lyon set the granite milestones, so now, with the exception of the first two stones, which were never furnished, a traveler going from Placerville to Lake Tahoe, or returning, may know the distance he has gone. The following table gives the length of road and cost of survey:

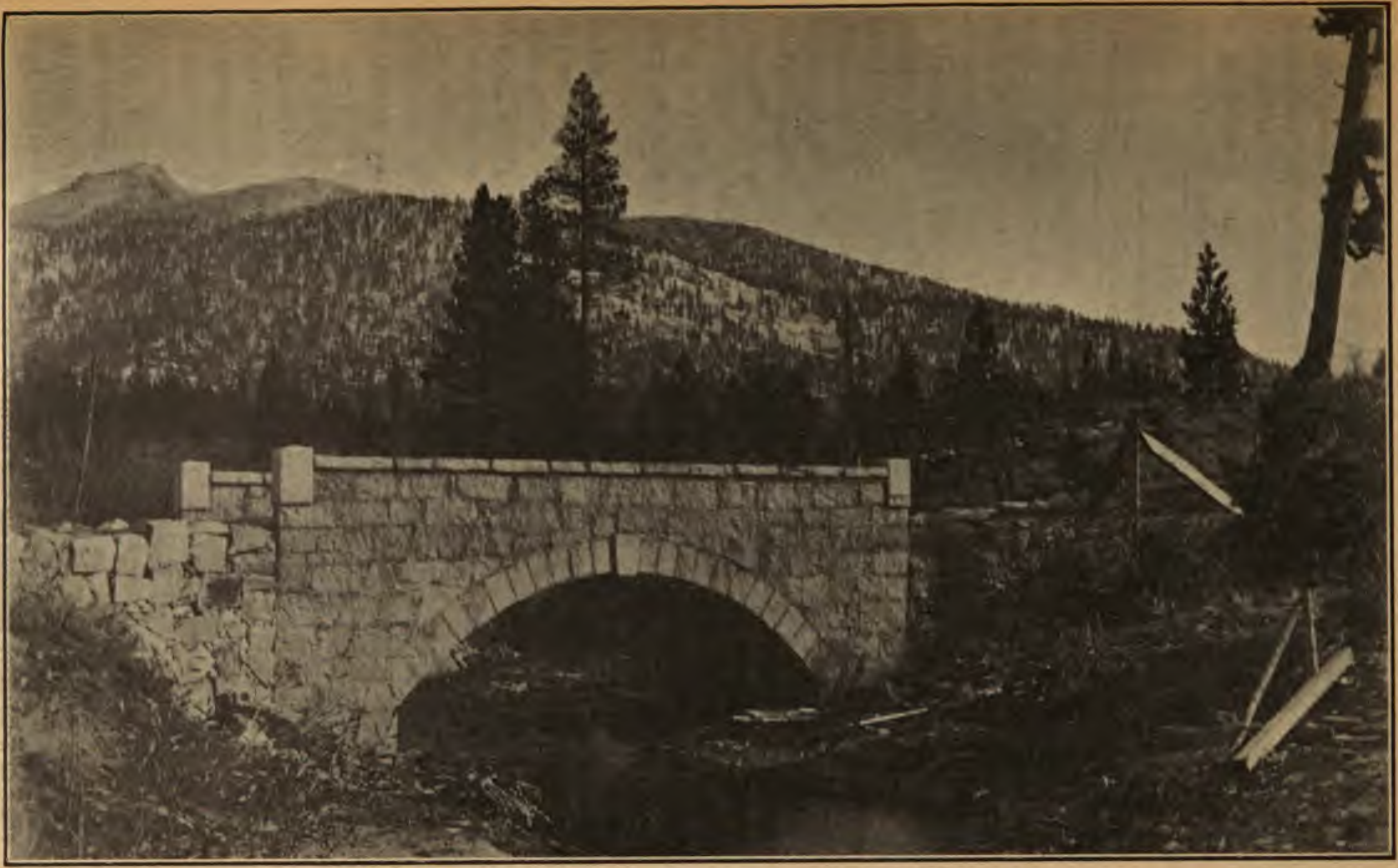
Lake Tahoe Wagon Road Survey.

Distance of total survey of road	61.91 miles
(From Placerville Courthouse to State line, Lake Tahoe.)	
Distance of survey made during 1907	36.83 miles
Distance of survey made during one day average, 1907	1.02 miles

Cost of Survey, 1907.

Engineer, levelman, and four helpers, with expenses	$1,124 11
Concrete blocks delivered	82 50
Total cost	$1,206 61
Cost per mile of survey, complete	32 76

From an intimate knowledge of the cost of a proper maintenance of



STONE BRIDGE, TROUT CREEK, LAKE TAHOE STATE ROAD.

this road, I therefore recommend the appropriation of $7,500 for the special treatment of the first fourteen miles of the road by either watering or oiling, and earnestly believe such would reduce the up-keep of this part of the road very materially.

For eight years we have struggled to get a better class of work on the structures, and now believe the expenditure as indicated would be very effective and an economical betterment.

SONORA AND MONO ROAD.

The 1907 session of the legislature appropriated $6,000 per annum for maintenance purposes, and this, in addition to the balance of about $12,500 in an appropriation for permanent structures on this road made in 1905, permitted the Department to accomplish many improvements.

The road as originally taken by the State, in 1901, was simply a rutted gully, which could be termed a road only in name. The roadbed was for great stretches a bed of boulders, the bridges were rotted out, and no culverts existed. Such a condition of affairs, with but meager funds to repair or practically rebuild a road, of seventy-eight miles in length through the Sierra Nevada Mountains, presented a gigantic task. However, at date, the vast superiority of the road in comparison with only three years ago, gives assurance that the road with adequate funds can be made over with excellent results. It is quite evident that a great number of beneficial changes in grade and alignment must be made before any permanent work can be applied.

Near the Huntoon Ranch, about eight miles from Bridgeport, a bad hill with a steep grade has been entirely eliminated by getting the right of way to construct the road around the hill, where at one time prior to the State's occupancy the road was located. From Leavitt Meadows to the summit of the Sierras, three very effective changes in grade may be made, and one positively must be made. The Quinlan grade of soft mire clay can be avoided by one half mile of extra road. Again, from Baker's Station to Deadman's Creek a very important change is necessary in order that a bad, slippery and steep solid granite roadway may be avoided for possibly three quarters of a mile. There are numerous minor changes to be made, but I have but called attention to the more pressing ones that we may get the road well drained with culverts and make some now dangerous places more easily passable. Until these changes are made no permanent work should be done on these stretches of road that eventually will be abandoned.

In this connection there should be a survey made of both ends of this road and also the necessary changes of location. The ends of the road are mentioned for the reason that the settlers and owners of abutting lands who are nearly all located at these points have a marked tendency to gradually infringe on the right of way.

A survey has its further value in giving the necessary data for change of grade and alignments. The Department is striving to get both ends of the road in good shape, while keeping the summit passable, and then work from both ways to the crest of the mountains. The ends are traveled much more than the section of road over the summit. In accordance with this plan during the year 1908 there has been erected on the Mono County end a combination bridge of 70 feet span with concrete abutments over the West Walker River to supplant an old wooden structure in dangerous condition. It was in this bridge that the steel from the Riverton bridge on the Lake Tahoe wagon road was used. A 25-foot reinforced concrete bridge with 16-foot roadway was erected at Junction over the east branch of the West Walker River. Two 20-foot span reinforced concrete bridges with 16-foot roadway and one 18-foot span reinforced concrete bridge were erected over small river crossings about one and one half miles west of Bridgeport. On account of cold weather we were unable to erect another 18-foot span reinforced concrete bridge near the three above indicated, but have all the materials on hand at its location, so that during next spring it can be readily built. From the isolated location of this work and its distance from rail connection it was deemed best to contract for these structures on a percentage basis. Therefore an agreement was made with Messrs. Jenkins & Wells, of Sacramento, to do the work on a ten per cent margin. Below is given a table of costs and estimates which when compared with similar work in more favored locations makes an excellent showing:

TABLE OF ESTIMATE AND COST OF SONORA AND MONO BRIDGES.

West Walker Bridge—	
Commenced August 1, 1908. Finished September 30, 1908.	
Span, 70 feet; clear height, 8 feet; roadway, 14 feet.	
Combination wood and iron bridge; iron work of the bridge used.	
New bridge material, cost	$350 71
77 cubic yards abutment, 96¼ barrels cement	481 03
Abutment, labor cost	593 68
Erection, labor cost	186 75
Inspection, cost	132 32
Contractor's commission	172 42
Total cost of bridge	$1,919 91
Junction Bridge—	
Commenced August 15, 1908. Finished September 28, 1908.	
Span, 25 feet; clear height, 4 feet; roadway, 16 feet.	
Reinforced concrete on concrete abutments.	
Preliminary work and excavation, labor cost	$128 29
40¾ cubic yards concrete, labor cost	349 35
60½ barrels cement, cost	386 78
7,574 pounds steel, cost	383 36
Forms, cost	56 45
Inspection, cost	132 32
Contractor's commission	141 32
Total cost of bridge	$1,577 87

Bridge No. 4—

Commenced August 21, 1908. Finished October 8, 1908.
Span, 20 feet; clear height, 4 feet; roadway, 16 feet.
Reinforced concrete on concrete abutments.

Preliminary work and excavation, labor	$128 80
36.4 cubic yards concrete, labor	322 60
51½ barrels cement	330 10
4,767 pounds steel	232 59
Forms	64 26
Inspection	132 32
Contractor's commission	118 72
Total cost of bridge	$1,329 39

Bridge No. 3—

Commenced August 31, 1908. Finished October 7, 1908.
Span, 20 feet; clear height, 4 feet; roadway, 16 feet.
Reinforced concrete on concrete abutments.

Preliminary work and excavation, labor	$130 29
32⅖ cubic yards concrete, labor	241 50
46½ barrels cement, labor	288 45
4,767 pounds steel	232 59
Forms, etc.	64 26
Inspection	132 32
Contractor's commission	106 61
Total cost of bridge	$1,196 02

Bridge No. 2—

Commenced September 23, 1908. Finished October 14, 1908.
Span, 18 feet; clear height, 4 feet; roadway, 16 feet.
Reinforced concrete on concrete abutments.

Preliminary work and excavation, labor	$69 55
27⅗ cubic yards concrete, labor	291 50
38½ barrels cement	232 20
4,334 pounds steel	219 76
Forms, etc.	64 26
Contractor's commission	98 63
Total cost of bridge	$1,108 22

Bridge No. 1—

No work done on account of weather.

210 sacks cement	$336 00
4,334 pounds steel	229 76
Form lumber, etc.	55 86
Total cost of materials stored	$621 62
Total cost of five bridges erected	$7,131 41
Material for bridge No. 1	621 62
Total	$7,753 03

With the accomplishment of the above work and the construction of one hundred culverts of concrete, vitrified pipe or stone, to date there remains one hundred and eleven culverts to be constructed west of the summit and one hundred and two east of the summit, besides three 8-foot bridges, five 20-foot bridges and two 15-foot bridges. A wooden bridge over the Stanislaus River, built by the Union Construction

Company without cost to the State, and the Eagle Creek bridge are in good shape, and will last at least eight or ten years.

Having had charge of this road for seven years, and knowing its needs, I therefore recommend a special appropriation of $12,000 for the purpose of making some of the foregoing suggested changes and the necessary surveys for them.

MONO LAKE BASIN ROAD.

There has been appropriated a maintenance fund of $1,250 per annum for this road, but as I regret to state the road is not yet wholly completed to its western terminus, and consequently this money has been applied only to the work finished under the first contract.

The contract of Mr. J. F. O'Brien for the construction of the last five miles, 593 feet of this road, has been delayed materially by scarcity of labor until the spring of 1908. At this time he was unable to proceed with the work, and I therefore notified the people on his bond to complete the contract. Although they have not yet done anything towards the construction, they assure me of the completion of the work next summer. As it is impossible to work in the winter time on account of the heavy fall of snow, and as the season is so short and the constructive work in solid rock so difficult it takes much longer to get the same result as a road constructed in the foothills. One great setback to the completion of the road was the damage done by a heavy blast set off in 1906, in the solid granite and tearing away the whole mountain side. In fact, the loss caused the contractor by this blast was very serious and probably cost $3,000 to cut out a roadbed of solid granite. This also delayed the work one year, as it took the greater part of one season to replace this section.

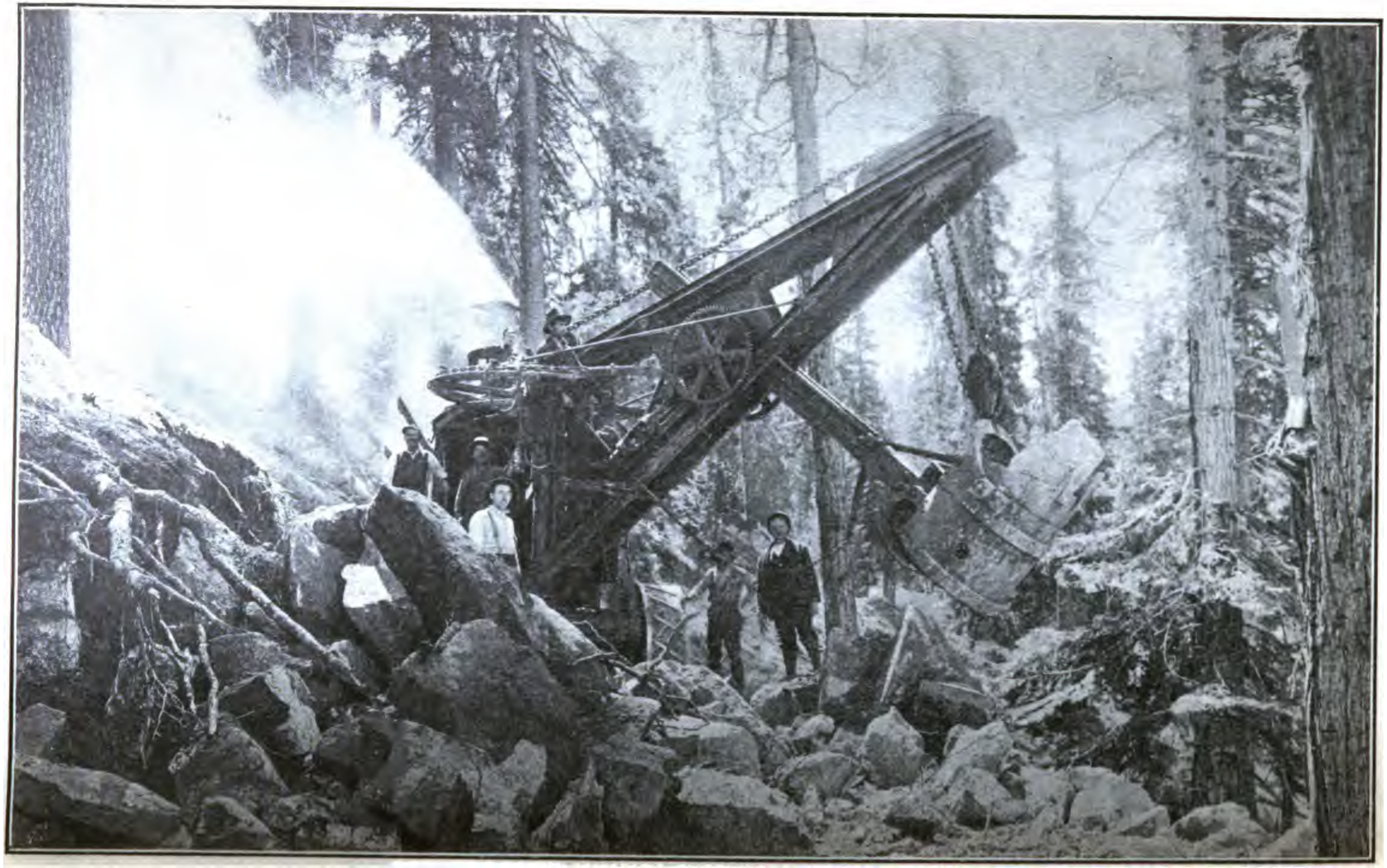
When this road is completed in 1909, there should be some action taken towards the improvement of the Tioga road proper. This road extends from Crockers Station, in the Yosemite National Park, to the lake at the head of Leevining Creek Canyon, or the western terminus of the State road.

The Tioga road has received little repairing, and consequently is in very poor shape for travel. Nearly its whole distance is in the bounds of the National Park, and should, therefore, be bought by the Federal Government and repaired. Unless this is done, travel by this route will be so badly handicapped as to make this beautiful country inaccessible to a great many people.

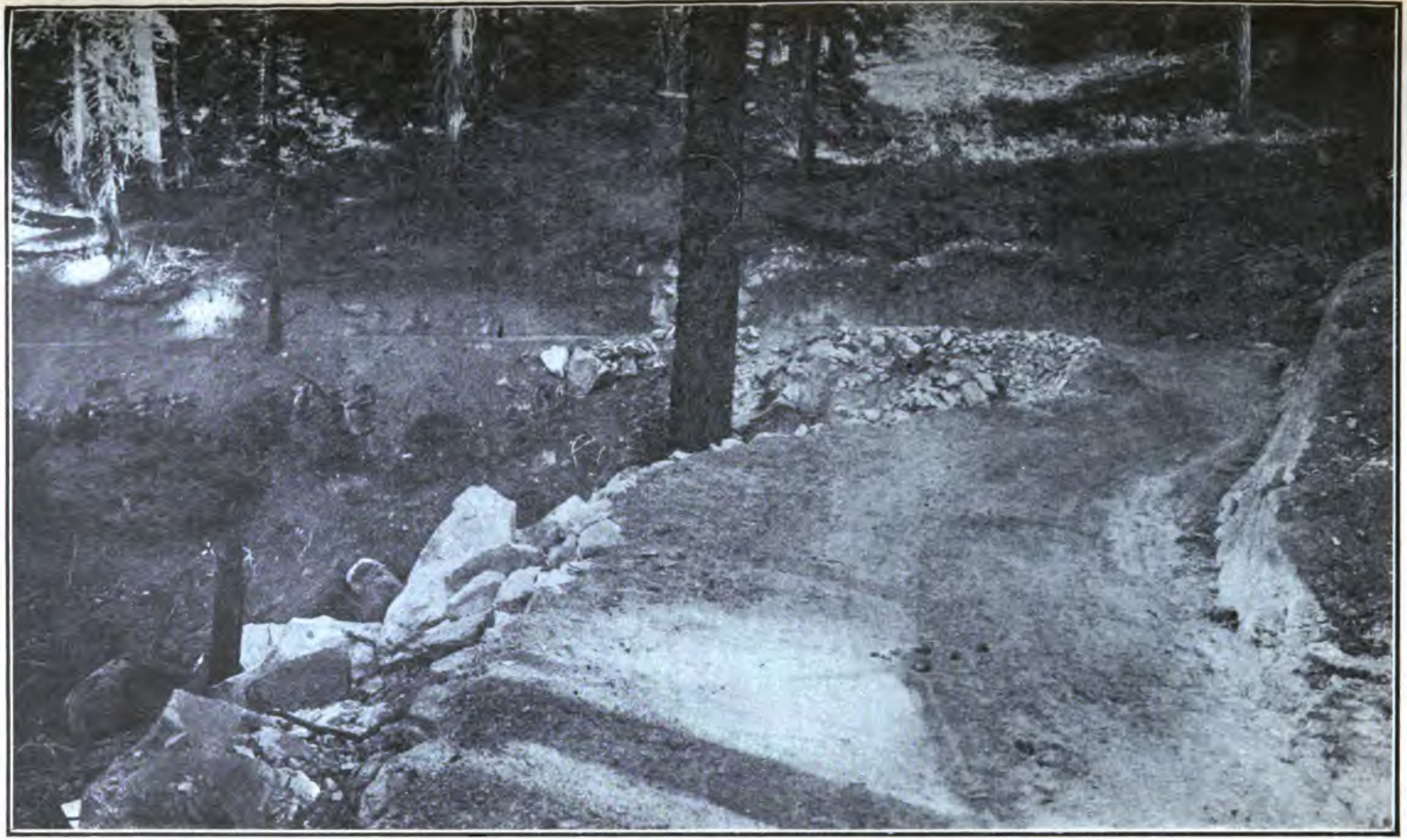
For the maintenance of the Mono Lake Basin road, I recommend an annual appropriation of $1,500.

KINGS RIVER CANYON ROAD.

The appropriation of $25,000 by the State, contingent upon the county of Fresno contributing 50 per cent as much, or $12,500, provided $37,500



STEAM SHOVEL BUILDING KINGS RIVER CANYON ROAD.



KINGS RIVER CANYON ROAD. CONSTRUCTED 1908. MAXIMUM GRADE 6 PER CENT.

for the survey, location, and construction of this most important scenic highway of the State. During the year 1906 a survey was made for the first 20.1 miles to a point near Horseshoe Bend on the South Fork of the Kings River. In 1907 the survey was continued under the charge of Mr. E. B. Henderson. He crossed the river near Windy Cliffs and then kept on the north side of the river to the end of the survey near the Cedar Grove Hotel, in the floor of the Kings River Canyon. A total length of 32.8 miles gives a road from the General Grant National Park to the floor of the wonderful canyon of the South Fork of the Kings River.

During the same year or 1907, the construction work was begun, under the direction of Mr. M. P. Ormsby, at the north gate entrance to the General Grant National Park and continued to within one half mile of the summit of the ridge between Ten-Mile Creek and Millwood. This year, under the charge of Mr. H. F. Hill, the work of construction was continued until about 5¼ miles of roadway had been built. The Department bought a 31-ton steam traction shovel and two small two and one-fourth inch Burleigh drills for this work, and after considerable effort the machinery reached Mr. Hill about August 20, 1908. On account of the softness of some of the roads we were compelled to transport the shovel by team at a considerable expense; however, it is already demonstrated that the steam shovel is the quickest and cheapest way of constructing the mountain roads of California. It cuts the cost of hand work by 50 per cent in moving the class of materials encountered on these roads, and adds greatly to the width and alignment. A bed of solid earth must be cut out to permit of the shovel to travel in, while a sharp spur or ridge, which ordinarily was encircled, is now cut through with a great deal less cost. Large trees, stumps and brush are cast over the waste edge of the road with facility, so that the cost of grubbing the road is minimized. From the short operation of this shovel it is plainly seen and proven that the mountain roads of California can be built at much less cost than originally figured, if the traction steam shovel is used.

For nearly the whole distance of this road some of the most delightful scenery of California is passed. Leaving the big trees at the General Grant National Park and skirting the west slope of the ridge a panoramic view of the San Joaquin Valley is seen. Then crossing the summit of the ridge and descending into Ten-Mile is, for the last two miles, in full view of the main Kings River Canyon and Tehipite from Indian Point. Crossing Ten-Mile Creek and gradually descending until Lockwood Creek is passed, suddenly the road emerges on the crest directly overlooking the confluence of the Middle and South Forks of the Kings River. Here a rough, rugged, and rocky country is traversed until past Redwood Creek, when the ground encountered is very good for the construction of a road. This continues until within one half mile of the river crossing. It is on this side of the mountain, of good road ground, that may be seen the great gorge of Windy Cliffs. Where the road switches back on a turn on the crest of a ridge, the view of a deep chasm fifteen hundred feet deep is, perhaps, unsurpassed in beauty, and at the foot of this gorge, where the road survey is along the river, is a cave of unknown dimensions. The mouth of this cave is very close to the road, about one hundred feet, and extends into the limestone of Windy Cliffs. Continuing on the north side of the river until Grizzly Creek is reached, a wild river gorge is traversed. Beyond Grizzly Creek the ground gradually flattens out into the floor of the canyon.

So rough and rugged is the general country through which this road is laid out that we were compelled to expend some considerable money in building trails from the main trail toward the river to permit of camp being made within a reasonable distance of the work. During 1906, I personally conducted the last few miles of that year's survey, and then saw the futility of getting men to continue the work of survey without being compelled to walk or climb three miles out of the canyon to camp in the evening. I have traveled over the whole country near the line of survey, and am fully acquainted with the difficulties met with in the work, and fully appreciate the obstacles overcome by a survey through a canyon where one misstep might precipitate one headlong one thousand feet below.

I herewith give a résumé of the survey of this road and also the cost of the construction. Before proceeding, however, I wish to call the reader's attention to a view herewith presented in this report showing the steam shovel at work in rock. Note the body of the rock has been blown out. For the most part all the higher foothills of the Sierra Nevada's and those high ridges of the same range that are well timbered show an earth material superficially, and most surely a granite formation just beneath this surface. This was encountered in the construction of this road, and, consequently, ran up the price of hand labor per mile of road. It may be plainly seen from the figures on costs that the steam shovel which handled the hardest part of the work, the last mile constructed, brought down the average cost per mile.

During 1906 there was surveyed 20.1 miles of road at a cost of $167 per mile, or $3,341.72 for the total distance.

The following year Mr. E. B. Henderson, with a party, began August 17, 1907, and finished the survey November 17, 1907. He surveyed 12¾ miles of road in the roughest part of the canyon at the cost of $211 per mile, or $2,691.22 for the complete distance.

During 1907 Mr. M. P. Ormsby began the work of construction of this road at the north edge of the General Grant National Park and built 1.6 miles at a cost of $4,040 per mile. He stored $1,100 worth of tools and equipment for the year 1908. Upon the beginning of work this year Mr. Ormsby was transferred to another road, as I contemplated a cheaper method of building by steam machinery, and therefore required the services of a man skilled in that line. Mr. H. F. Hill took charge of the road and continued the work by hand until after numerous delays a shovel was delivered to him, and then he was able to run only one month, when the work had to be closed down on account of winter weather and the inability to hold men in that high altitude late in the year. Work began May 26th and ended October 28, 1908, with the results as tabulated:

3.5 miles finished 1908, cost	$13,103 00
Average cost per mile, 1908	3,750 00
Equipment stored, 1908	6,690 00
Hand labor per mile, 1908	2,330 00
Labor steam shovel, per mile, 1908	1,300 00

After carefully comparing hand work with steam shovel work, it is concluded that it will require about $50,000 to complete this road, without the bridge at the mouth of Boulder Creek, which will probably cost $5,000. Therefore, it is recommended that $50,000 be appropriated for this work, and that the road be made a State road, for obvious reasons connected with the maintenance. Through the scheme of paying partly for a road by a county and partly by the State the Department has been subjected to unwarranted severe criticism for the nonpayment of claims promptly. This occurred by the State claims being allowed within one week from presentation for audit, and the one third payable from the county appropriation has been out from a month to six weeks, depending upon the set meetings of the board of supervisors. I have carried numerous labor accounts on my personal funds to facilitate the work of the Department, but feel that a considerable portion of it could be obviated by a different manner of making the appropriations.

ALTURAS AND CEDARVILLE ROAD.

The State, at the session of 1907 legislature, gave aid to the county of Modoc in the repair of the Alturas and Cedarville road in the sum of $7,000. This amount, however, to be expended from the state fund after the county of Modoc had expended $3,500 on the same road. The writer made a trip between Alturas and Cedarville, in company with the county supervisors of the district, and viewed the work done two years ago by the State and the work done by the county during 1907 and 1908. These improvements were found to be substantially as they were finished and in excellent condition. Shortly after the county had expended the $3,500 designated by the statute of 1907, the Department began the work, September 26, 1908, of improving this highway. The following work, with costs, was done under the direction of Mr. J. H. Godfrey:

2,000 cubic yards material, gravel and rock, hauled on road	$1,544 49
Material cost per cubic yard	77
600 square feet of rough rubble wall	11 25
6 culverts built of stone	86 25
1 bridge and culvert repaired	72 43

The Alturas-Cedarville road is one of the commercially important roads in California. It is the main artery for all supplies to and from Surprise Valley and railroad connections. From Cedarville to Alturas is twenty-five miles through foothills and the Warner Mountains. The nature of the soil and rock, adobe and lava, two of the most difficult materials to make a good road of, practically continue throughout the whole distance. The treatment of this road is therefore a problem that can only be solved by sand and gravel surfacing. The appropriations from the State have not been sufficiently large to allow of good first-class substructures, such as concrete or vitrified pipe culverts, but the money has been chiefly applied to cutting out bad grades and surfacing the road.

SIERRA STATE ROAD.

The problem of getting a road from Downieville to Mount Pleasant on the Quincy road, was necessarily more difficult than if the country traversed sloped with the water shed. On this route, however, we were compelled to go contrary to this plan and cross the watersheds. Thus, to obtain a proper survey for the roadway caused more work, time and expense than ordinarily. A realization of this fact is foreign to the layman and he looks upon the expense of surveying as something superfluous. However, an improper survey in this character of country, crossing the water courses, may cost many thousands of dollars in construction, which most likely, with the expenditure of money for preliminary survey work, would have saved fifty times the cost of such work. Improper location of roads is evidenced throughout California, both by the difficulty of traveling and the expenditure of maintenance money. The State has so far obviated the catchy scheme of cheap, faulty location with the eventual heavy cost of maintenance.

There has been surveyed 14.52 miles of this road and there remains about six miles to be surveyed. I herewith present a table of cost of the survey, including office work, of getting out plans, maps, profiles, specifications, and cross-sections, with estimate of materials to be moved and cost of moving the same:

Table of Survey Costs.

Distance of survey 14.52 miles, total cost	$2,602 35
Cost per mile	179 22
Work of platting cross-section, estimate, etc., cost	485 00
Work of platting, cross-section, estimate, etc., cost, per mile	33 33

The survey began July 15, 1907, under the charge of Mr. J. B. Gray, but before completion he was recalled and Mr. Geo. W. Kimble placed in charge. The snow drove the party out October 22, 1907. The following year, or 1908, it was decided to start the construction work, provided the rights of way were obtainable. Where the survey crossed the ranch property of Messrs. Denari and Rasasco, through some cleared land, $1,000 was asked the State for this particular right of way. After a trip on foot over the whole survey, June 20 and 21, 1908, I decided to place the matter of obtaining these rights before the county board of supervisors, and should they secure them to then proceed with the work. Therefore, without cost to the State, all rights of way have been secured as far as Eureka.

On July 20, 1908, a crew, under the charge of Mr. M. P. Ormsby, was sent to Downieville to construct as much of the work as possible this year for the available money. Below follows the table of work with costs:

Table of Construction Work and Costs.

Wall building, loose rubble, 11,430 square feet, cost	$228 60
Grubbing and clearing roadway, 20,880 lineal feet, cost	605 72
Material removed, 13,260 cubic yards	5,434 55
Equipment and supplies on hand	1,750 00
Total expended	$8,018 87

Cost of moving material per cubic yard, 41 cents.
Cost of building one mile of road, $2,161.
Length of road built, 2.9 miles.

This road gives that section of the State a cross road, traversing a mountain range between two nearly parallel roads, which have been wholly inaccessible to each other by any reasonable distance. The grade established on the State road does not exceed 6½ per cent, which for that mountainous district is exceedingly easy. The width of roadway is 12 feet, with turnouts of 18 feet width and 100 feet in length.

The estimated cost of the completion of this survey and work of construction is $35,000, which I recommend, in addition to the original appropriation of $12,000.

TRINITY-TEHAMA-SHASTA-HUMBOLDT ROAD.

In 1903, $1,800 was appropriated for a survey along the Trinity River, from a Humboldt County road to North Fork, Trinity County. This survey was made from near the South Fork of the Trinity along the main river, for a distance of 21.57 miles to a point between Don Juan and Taylor's Flat, when on account of the lack of funds the survey was discontinued. After a lapse of four years the Trinity road matter again came to the attention of the legislature, and at the 1907 session $50,000 was appropriated with the view of obtaining a State highway connecting the roads of Humboldt County with those of Trinity, Tehama, and Shasta counties. The location of the route was placed under this Department, and therefore, on August 22, 1907, a survey party under the charge of Mr. J. N. Lentell was started out over what is known as the Low Gap of Mad River route. The survey began where the present Low Gap road ends and continued up South Fork Mountain to a low saddle thereon—elevation 4,000 feet—then descended to the South Fork of the Trinity River; thence up Rattlesnake Creek and Post Creek to its source; then, with a slight drop, ended on the road between Hay Fork and Red Bluff at a small station known as Peanut. The distance of this survey with auxiliary lines was 31¾ miles. From here Mr. Lentell and party proceeded to North Fork at the junction of the main Trinity River and its fork, and began a survey down the main river on the north side for a distance of 22.23 miles, where he tied on to the survey made in 1904, under a former appropriation. He also examined the so-called Hennessey road—a road being constructed by private enterprise from Burnt Ranch, on the Trinity River, over a range of mountains to the South Fork branch of the Trinity, and reported as follows:

REPORT ON HENNESSEY ROAD AND CONTINUATION.

January 1, 1908.

" Mr. N. Ellery, *State Engineer, State of California.*

Sir: I went over the Hennessey road and found it from Hennessey's house to the summit of the divide and about a mile west of the summit graded, the grade being about 6 per cent, in a few places running up to 7 per cent. The road between these points is very crooked, being a series of loops, to get down from the summit on each side. From the point a mile west of the summit there is about a mile of unfinished road. From here, however, the road continues in a straighter line with very few loops until it reaches South Fork.

The road on the west of the divide, already completed and estimated about eight miles long, is on an even grade and does not exceed 6 per cent, except for about half a mile near South Fork, where it is between 8 per cent and 8½ per cent. The width for the lower three miles is about eight or nine feet solid roadbed, in some places a little less; the upper five miles about nine to ten feet in width, except about two miles where the slope of ground is slight it is 14 to 16 feet wide.

The elevations on the foregoing road are 2,100 feet at the eastern end, near Hennessey's house, and 3,100 feet at the summit of the divide.

I think it inadvisable to use this road at all, as the river road is the thing, for 3,100 feet elevation is too great a climb when a river road grade can be obtained. In the construction I might add, that my opinion is that the river route should be located on the north side all the way down. If the river is crossed then I would advise crossing at Dixon's Bar, about two miles below Don Juan Point.

I investigated the Berry Divide to the south of the present road and found the pass mentioned before in our conversation to be 880 feet lower than the highest point on the present wagon road between Redwood Creek and Trinity River, and about two miles further south than the present road.

I enclose you list of elevations.

Respectfully,

J. N. Lentell."

The following is a list of elevations furnished by Mr. Lentell:

Elevations on Trinity River Route.

End of Ellery's survey, 1904, Trinity River	1100′	barometer
Don Juan Bridge, Trinity River	1000′	barometer
Trail to McDonald's (U. S. Government Survey, B. M.)	1732′	
McDonalds, (below Burnt Ranch)	1560′	barometer
Hennessey's House (Burnt Ranch)	2035′	barometer
Summit of Hennessey road	3100′	barometer
Bridge at mouth of the South Fork of the Trinity	470′	barometer
Willow Creek Hotel (U. S Government Survey, B M.)	462′	
Divide between Trinity River and Three Creeks (U. S. Government Survey, B. M.)	3123′	
Three Creeks (lowest)	2280′	
Summit between Trinity River and Redwood Creek (U. S. Government Survey, B. M.)	3720′	
North Pass above Berry's old house	2930′	barometer
South Pass above Berry's old house (1 mile south)	2880′	barometer
Berry's house, near Redwood Creek (U. S. Government Survey, B. M)	1038′	
Bridge over Redwood Creek	878′	barometer
Green Point Ranch at Marsh Place	1430′	barometer
Divide between Redwood Creek and North Fork of Mad River	2350′	barometer

The survey on the Trinity River was completed December 19, 1907, and after the field notes were received by the office, I placed a draftsman at work plotting the notes for comparative costs on the two routes as surveyed.

After these notes had been properly worked out, I received a petition of the people of Hyampom and Hay Fork for the survey of the route leading from Hay Fork down Hay Fork Creek to Hyampom, thence down the South Fork of the Trinity River to Grouse Creek; up Grouse Creek to its head; then down on to the Mad River, somewhere near Mountain View.

The purpose of the Department being to obtain as much data as possible, to lead to a proper decision in the selection of a route, I therefore went to Eureka, and on August 27, 1908, started for the Mad River section, traversing the country around the head of Grouse Creek, South Fork Mountain between Hyampom and the mouth of Grouse Creek, and then proceeded to Burnt Ranch, when on September 1, 1908, I examined the Hennessey road in company with Mr. Hicks, the superintendent of construction, and found what work was accomplished, done in an excellent manner. On the east slope of the summit over which this road passes, there must be done considerable work, and on the west side, at least a mile of quite difficult road must be built. Ten to twenty thousand dollars ($10,000 to $20,000) must yet be spent to give this road a grade to permit of travel. All culverts are made of poles which are the merest temporary construction.

After the examination I went along the survey up the Trinity River and carefully noted the character of country as far as North Fork. There is no question as to the excellency of a grade up the river proper, but the material is largely tough rock, very expensive to work. When once a road is constructed, however, a solid bed is secured, practically indestructible.

Upon the completion of the survey of the Mad River route in September, 1907, I visited and traveled by foot most of the survey. The material is largely soil, with some quantity of rock on Rattlesnake Creek. There is, however, no necessity to exceed at any point, a six per cent grade, even though the survey runs across the line of water courses. This feature is an objection for proper construction, but is taken up farther on in the treatment of a road completely across this section of the State. To properly decide the location of this important State highway, it is necessary to compare the following features:

1. Public service.
2. Possible development of territory.
3. Distances, grades, elevations, and mileage to construct.
4. Character of ground traversed and bridges.
5. County road approaches.
6. Cost of routes.
7. Snow and sun exposure.
8. Maintenance of road after construction.

The whole problem is treated by first making the assumption that the objective points to be reached or brought together by a road system are the cities of Red Bluff, Redding, Weaverville, and Eureka, and that Humboldt Bay is the objective point of the three interior cities. These places are the county seats of their respective counties, and certainly represent the centers of public interest in the matter.

From the point of view of public service, the road should be so located as to give these county seats the quickest and best connection and still serve the greatest number locally. Taking Eureka as a starting point and designating the three probable routes as the Trinity River route, Hyampom route, and the Mad River route, I will, after describing them generally, give approximately the local tributary traveling public to each route.

The Trinity River, or the northern route, passes over the present county roads through Arcata, Blue Lake, Korbel, and Willow Creek, in Humboldt County, then turning south from Willow Creek, extends to the mouth of the South Fork of the Trinity where the road bears southeasterly over the Hennessey road to Burnt Ranch, on the Trinity. From here a survey extends up the main Trinity to Helena, Trinity County; then by county road through Junction City to Weaverville. From this point either Redding or Red Bluff may be reached.

The Hyampom, or central route, passes through Freshwater, then by the way of Mad River reaches the head of Grouse Creek, down such creek to its mouth, where it turns to the south along the South Fork of the Trinity River to Hyampom; then up the Hay Fork Creek to the town of Hay Fork, from where any of the towns of Weaverville, Redding, or Red Bluff may be reached by present road. The new road by this route would be from the Mad River to Hay Fork.

The Mad River, or southern route, would leave Eureka and pass by present road through Fortuna, Alton, or Rohnerville, Hydesville, and Bridgeville. From Bridgeville the road extends along the Van Duzen over the Low Gap Ridge to Mad River; then the survey made by the Department crossed South Fork Mountain to the South Fork of the Trinity River; thence up Rattlesnake Creek and Post Creek to a small station named Peanut, on the Red Bluff-Hay Fork road. From here the present road through Hay Fork leads to Weaverville and Redding, and the opposite direction leads to Red Bluff.

The Trinity River route would directly benefit Arcata, Blue Lake, Korbel, Willow Creek, Helena, and Weaverville, and a local scattered mining population along the Trinity River, and indirectly Eureka.

The Hyampom route would directly benefit Eureka, Freshwater, Hyampom and Hay Fork, and indirectly Weaverville, Redding, and Red Bluff, while little intervening population on the part to be constructed would be found. The Low Gap route would directly benefit

Fortuna, Alton, Rohnerville, Hydesville, the rich Eel River Valley, Bridgeville, Hay Fork, and Red Bluff, and indirectly Weaverville, Redding, and Eureka. On the part to be constructed scarcely any population exists.

Therefore, so far as serving the centers of population of the interested counties the three routes each have one county seat directly benefited, but so far as population along the new part is concerned, the Trinity River route is first in position.

For brevity permit me to designate the routes as follows: Trinity River route "Route A," Hyampom route "Route B," Low Gap of Mad River route "Route C."

For development of the adjoining country Route A would certainly give the Trinity River mining section an opportunity to open to its full extent. Route B would cross a stock country on its western end and timber on its eastern part. In the little Hyampom Valley a small agricultural section would be vastly benefited. Route C would have a western section in a stock country and pass through considerable pine timber

I would decide in favor of Route A for development opportunity along the route.

In number 3 we have a vital contention, which is a great influence in the determination of a route. Means of communication seek the shortest and easiest route, and I might say cheapest for the same reasons although not so generally recognized, a railroad does.

In the matter of distances, grades, and elevations there is a considerable variance. On Route A a fine grade, not exceeding three per cent, may be had between Burnt Ranch and Helena, a six per cent or six and one half per cent from Burnt Ranch to South Fork. The greatest elevation on this part of the route is 3,100 feet.

Route B can be constructed with a six per cent grade from Mad River to the South Fork of the Trinity, then three per cent on to Hay Fork. The greatest elevation is approximately 3,600 feet, at the head of Grouse Creek.

Route C will require a six per cent grade from the Mad River crossing to a point on Post Creek, then about four per cent grade to Peanut. The highest elevation is approximately 4,000 feet, at the saddle crossed on South Fork Mountain. The grades, on the existing county roads on the ends of the connecting link, that go to make up a good route continuous between county seats are the same as the majority of mountain county roads, excessive grades in places with no uniformity. The lengths of the parts of the different routes to be constructed are as follows:

Route A—Helena to Burnt Ranch, 32½ miles by survey. If Hennessey road were used, then add 15 miles of length, perhaps 6 miles to be reconstructed near summit and east side of the summit.

Route B—Hay Fork to Mad River, somewhere near Mountain View, 58 miles to construct.

Route C—Mad River Low Gap to Peanut, 28 miles by survey.

While these distances, grades, and elevations are interesting, yet the following table gives the most important comparison on this subject:

Table of Approximate Distances.

Eureka to Weaverville (Route A)	119 miles.	To build, 32½ miles.
Eureka to Weaverville (Route B)	100 miles.	To build, 58 miles.
Eureka to Weaverville (Route C)	126 miles.	To build, 28 miles.
Eureka to Redding via Weaverville and Route A		164 miles.
Eureka to Redding via Hay Fork and Route B		131 miles.
Eureka to Redding via Peanut and Route C		157 miles.
Eureka to Red Bluff via Weaverville and Route A		199 miles.
Eureka to Red Bluff via Hay Fork and Route B		143 miles.
Eureka to Red Bluff via Peanut and Route C		162 miles.

The comparative value of the Hyampom route in distance to the three county seats on the eastern end should be noted. In fact, from Eureka to Weaverville by Route B it is 19 miles shorter than by Route A.

The character of the ground varies much on the different routes. On Route A a great portion of the part to be constructed is in solid rock and some stretches of talus. There are some places, such as Taylor's Flat and opposite Tinsley's where good road ground is encountered. See table of comparative costs on quantities of different materials to be excavated. Route B, so far as observed when on my trip, would obtain over the greater portion, earth excavation although some solid rock is in the line of road at many places.

Route C is mostly over soil with considerable rock on Rattlesnake Creek. Again, see table of costs given later.

The total lengths of bridges encountered on the three routes are in the following order: Route B, Route C, and Route A—Route A having the greatest number of lineal feet. It appears Route C has the best material over which a road could be built.

The county road approaches must receive the serious consideration due in the selection of a State road. The road from Eureka to Korbel is very good, with few grades, and they only incident to small ridges around Humboldt Bay and up Mad River.

Leaving Korbel, however, the road ascends the mountain and then descends to Redwood Creek crossing. Again ascending steeply up what is known as the Berry hill to descend after reaching the crest to Three Creeks, where one must climb over another ridge to reach Willow Creek. From Willow Creek the road to South Fork is over good ground, with no grades worthy of mention. Crossing the South Fork of the Trinity River we begin the climb over the divide to Burnt Ranch. From here up the river the grade can be made on a 3 per cent basis to Helena. Before reaching Weaverville. from the last named point we must climb over a mountain on both sides of which the road is very steep. Between Weaverville and Redding and Red Bluff one main divide is encountered. This makes five ridges to cross to reach Weaverville from Eureka, and six to either Redding or Red Bluff by Route A. It is possible to avoid the ridge between Three Creeks and Willow Creek by making a new road to the south of the present county road, and thus also greatly improve the grade.

Route B presents the Kneeland Prairie hill, the divide at the head of Grouse Creek, and a divide between Hay Fork and Weaverville. To reach Weaverville three divides are crossed, while to reach Red Bluff three mountains must be climbed, and to reach Redding four.

Route C extends up the Eel and Van Duzen rivers to Bridgeville, then over a mountain to again reach the Van Duzen; up the Van Duzen to the Low Gap of Mad River, which can scarcely be classed as a mountain divide. Over this, however, we then cross the Mad River and climb over South Fork Mountain to the South Fork of the Trinity River; thence over the slight divide at the head of Post Creek. To reach Weaverville or Redding we must pass through Hay Fork, across one divide to the former, two to the latter, while Red Bluff requires but to climb the one main divide beyond Peanut.

On the Eureka end Route B would undoubtedly have the best approach, as the county roads leading to the other two routes are poorly located and constructed.

On the eastern end Route B again has the advantageous approach, while Route C has the second best approach.

In regard to the cost of the routes I will give the following table of approximate results in connection with the surveys of the two routes A and C, and an estimated cost from mere observation of Route B.

Table of Materials and Cost from Surveys.

Route.	Earth Cut, Cubic Yards.	Loose Rock, Cubic Yards.	Solid Rock, Cubic Yards.	Bridges, Lineal Feet.
A	101,150	63,000	95,000	3,600
C	111,350	37,000	15,000	2,800

Placing the cost of removing earth, including grubbing, at 35 cents per cubic yard, loose rock at 50 cents per cubic yard, solid rock at $1.20 per cubic yard, and bridge work at $20 per lineal foot, Route A would cost $180,900, with bridges costing $72,000, and Route C would cost $75,470, with bridges costing $56,000.

Route B will cost for the fifty-eight miles, approximately, one hundred and fifty thousand dollars ($150,000).

Route C will cost by far the least to make the connecting link, but will not give the same character of road as Route B.

The three routes are best compared for snow and sun exposure from Eureka to the center of Trinity County. Route A, after leaving Korbel, skirts the shady side of Bald Mountain through considerable timber, and in crossing at present the high divide above Berry's place encounters much snow. Up the South Fork from Willow Creek the road is on the wrong side of the river for sun. Also when the ascent of the Hennessey road is made a mile or two of shady road is traveled. Up the Trinity River, however, the north side of the river could be selected for the location, thus avoiding snow and having a fine sun shine.

Route B would encounter some shady road if the Kneeland Prairie road were made part of the route, but from the Mad River crossing practically to Hay Fork the sunny slope of the mountains is used. The only snow encountered would be the head of Grouse Creek, which, in a hard winter, is considerable.

Route C from Hydesville passes through considerable timber, which retains the moisture, but the road is constructed on the proper side of the Van Duzen River. From the summit above Bridgeville to the Van Duzen the road is on the wrong mountain slope. To get down from the saddle on South Fork Mountain we were compelled to use the shady mountain side as far as the South Fork River. From here on the survey extends on either side of Rattlesnake Creek, thus dividing the road's chances to dry out in the spring of the year. On the South Fork summit there is considerable snow in winter and spring.

It is, therefore, given that route A, if changed on Berry hill, would be freer from snow than either of the other routes, but that Route B would get more sun exposure and consequently an earlier spring road would result.

Route B is the best of the three for sun exposure, and Route A would be the best for snow, if the Berry hill were changed.

On the subject of maintenance, the solid rock bed can not be disturbed by the elements, but the covering to prevent the protrudence of rocks can be washed away and must be always protected. The earth road will cut out by allowing water to run down a slope, but the 6 per cent maximum grade used on State mountain roads keeps the erosion down to a limit of about one third the ordinary county mountain road with the heavy pitches or grades they most always possess. If properly cared for, routes C and B on newly constructed parts would be about even, and Route A would exceed the maintenance cost of either of the above two routes. Again, Route B would have a greater mileage of new road, and, consequently, a better grade than the county roads on the western end of the other two routes.

From the general investigation I have made of the territory through which the road must pass, the Hay Fork route has not received a sufficiently close inspection along Hay Fork River to give a proper decision.

Between Route A and Route C, however, there is little question. Route C is so much cheaper of construction, with distances between the county seats about the same, practically no difference in grades, serving the people equally except locally the Trinity River mines would receive an impetus; county road approaches about equal on west end, but superior on east end so far as Weaverville is concerned, that I can not decide for other than Route C. The comparative cheapness of Route C makes it the most reasonable line unless that part of Hay Fork River proves very easy of construction.

Owing to the request of a survey of Route B after the surveys for Routes A and C had been worked out and compared, the work of construction was necessarily delayed until nothing could be done this winter with any degree of satisfaction. Labor is difficult to hold in tents during the winter, and the swollen streams preclude getting in supplies.

It is, therefore, the intention of the Department to begin work at the earliest possible date of the spring of 1909. However, before the snow melts, I shall make the trip down the Hay Fork River and over the various divides and mountains to ascertain the relative amount of snow. In the construction of this road, a steam shovel could be used with great effectiveness and reduce the cost at least 40 per cent from hand and team labor.

Herewith is given the time and the costs of the survey of the two routes A and C: Survey began August 22, 1907, and ended December 19, 1907, or 119 days were occupied to survey 53.98 miles. Total cost of survey, 53.98 miles, $4,230.94. Cost per mile of field work, $78.38; total cost of office work, $1,722 ; cost per mile, office work, $31.90.

Office work constitutes platting, the making of profiles for grades, cross-sections for the calculation of cuts and fills, and cost of construction.

ECONOMIC RESEARCH.

From the beginning of its existence the Government of the United States has been engaged in making surveys of its territory. For many years the principal surveys on land were conducted by army engineer officers under the direction of the War Department.

In 1879–80 the U. S. Geological Survey was organized under the Interior Department, with Clarence King as Director. The first comprehensive report was published in 1882, by J. W. Powell, Director, and was devoted almost wholly to the treatment of structural geology. (The first annual report by King, in 1880, only dealt with the plans of organization and publication.)

The report of 1883 took up the subject of paleontology and mineralogy. In 1884 the new subjects treated were topography, artesian wells, and pleobotany. The report of 1885 mentions new methods in silver determinations, reports on swamps and on flora. In 1888 salt making was introduced into the investigation. In 1889 the study of petroleum and gas was taken up, and the researches of the survey reached California in a "Quartenary History of Mono Valley," "Geology of Lassen Peak District," and "Geology of Quicksilver Deposits of Pacific Slope."

The report of 1889 discussed the great Charleston earthquake.

The twelfth annual report, 1890, Part II, was devoted to irrigation. Each succeeding year witnessed the expansion of the system of investigation, until now it includes so many economic subjects that the survey is organized into six branches, subdivided into twenty divisions. Each division is again subdivided into sections according to the subjects to be investigated by it.

So important are the results of these investigations regarded by the public, the distribution of publications of the Survey now amounts to a million copies a year.

COÖPERATIVE WORK.

The Government, through its coördinate branches, including the United States Geological Survey, Experiment Stations, and Forestry Service, is so well prepared, with their organization, experienced staff and complete equipment, for accurate investigation along such extensive lines of economic development, that the reports of its work are sought for by public and private interests, and their accuracy accepted without question.

But the field of operations, embracing the entire country, and even extending into foreign territory, is so large that the appropriations made for them, liberal as they may be considered, are not sufficient to enable as rapid progress to be made as seems to be demanded by the needs of rapidly advancing communities.

To expedite investigations, which otherwise would have to wait for the Survey to reach them in its regular course, many states are coöperating in certain lines of inquiry in which they are most interested.

In the matter of topographic surveys, seventeen states are coöperating, for which $100,000 is allotted out of the general appropriation for the Survey, contingent upon the amount to be expended in each state being met with a like sum from that state.

For several years past the legislature of California has appropriated various sums for the purpose of coöperating with the Government. Contracts are annually made between the State, represented formerly by the Board of Examiners, and now by the Department of Engineering, on one side, and the Federal authorities on the other, as follows:

With the Director of the United States Geological Survey—

A. For the extension of topographic surveys within the State;

B. For investigation of water supply, conservation and utilization;

C. For investigation into the economic quality and purity of the waters of the State.

With the Director of the Office of Experiment Stations, Department of Agriculture—

D. For the investigation of the distribution, use and methods of application of water for irrigation; needs and methods of drainage.

With the Forest Service, Department of Agriculture—

E. For the investigation of the forest resources of the State and methods of forest conservation.

The gathering of information concerning all of the subjects above named is a proper function of the Department of Engineering, but to provide the Department with all the necessary equipment for field and laboratory work, and to maintain the necessary working force would require a large appropriation, and much of the work would necessarily be duplicate of a great deal that has been done before.

The Federal Government is already organized with a corps of experienced investigators, possessing all the best apparatus and instruments. As stated before, the field is so large that when the appropriations of Congress are allotted, the amount of work that can be done in any one state is comparatively small. The policy of the Government, however, is to give preference to those states which make appropriations for the same purposes, and the practice is to allot an amount equal to the State's appropriations for coöperative work.

In addition to other advantages resulting from coöperative work, it should be remembered that for every dollar so appropriated by the state another dollar of Federal money is used, and 90 per cent of the whole is spent within the State.

In conducting the investigations included in the coöperative work, it often happens that conditions arise which demand more extensive investigation along particular lines than had been contemplated, but work can only be carried to the extent of the appropriation for that particular branch.

It is believed that better results will be obtained if the State has a right of selection in conducting coöperative inquiry, and it is earnestly recommended that all appropriations for investigations in coöperation with the Government be made in one sum, and the allotment of the same for the different lines of investigation be left to the discretion of the Department of Engineering.

A.

TOPOGRAPHIC SURVEYS.

The charts or maps issued by the Government as the result of the topographic surveys made by the Geological Survey are marvels of completeness and accuracy of detail. All principal objects, natural or artificial, such as streams, lakes, shore-lines, reservoirs, canals, important wells and springs, railroads, highways, principal houses, villages, towns and cities, quarries, mills and other industrial plants—all are depicted with wonderful clearness and fidelity to position. Variations in the earth's surface are shown by contour lines of five, ten, fifty, or one hundred feet vertical intervals, all being referred to sea level. Elevations above sea level of prominent points are given in figures.

Prior to July 1, 1906, there were 74,948 square miles of the State's surface surveyed, and during the year 1906-7, 4,433 square miles of new area were added, so that on June 1, 1907, there were 79,389 square miles covered, making a little over fifty per cent of the entire State.

Under the coöperative agreement with the State the topographic surveys have been extended to include all of the Sacramento Valley below the 300 foot contour and lying west of the Sacramento River, from Iron Mountain to Suisun Bay, and on the east side of the river from the thirty-eighth degree of latitude which crosses the valley just north of Stockton and extending north to the thirty-ninth parallel near Marysville. This comprises about four fifths of the valley, and includes nearly all of the Sacramento Drainage District.

In the Sierra region the joint survey has covered Yosemite Valley, for which a special map was issued, the headwaters of the Merced River and adjacent streams, San Joaquin, Kings, and Kern rivers, and the mountainous portions of Tulare County.

Along the coast the Salinas quadrangle and part of the San Bernardino region have been surveyed, and east of the mountains Owens River Valley has been covered.

With the exception of the Salinas quadrangle and that portion of the Sacramento Valley lying east of the river, which were surveyed this summer (1908), the maps have been published and copies furnished to this Department. These maps are of inestimable value to all who are engaged in the study of contemplated irrigation, drainage, reclamation or power development enterprises.

Fixed Datum. In connection with the topographic survey, there are being placed on both sides of the Sacramento River, solid concrete monuments, in which are embedded aluminum tablets giving the elevation to the nearest foot, and the recorded notes give the exact location in feet and fractions. The elevations are determined by precise level lines run and checked with the utmost care, and are referred to mean sea level as determined by long series of tidal observations. In addition to these monuments, the survey places permanent iron "bench marks" at intervals all over the territory covered, and the elevations of these bench marks are marked and recorded in the same manner. By this means surveys made in any part of the State can readily be connected with these Geological Survey levels, and all reduced to a common base. The importance of this may be understood when it is stated that in the city of Sacramento no less than six different datum planes have been used, so that an elevation of, say, six feet reported by one survey may be actually higher than ten feet reported by another.

The Department is engaged in reducing all elevations given in the records of the office to the Geological Survey datum, and in conjunction with the local office of the Weather Bureau river gauges are being connected with the Geological datum.

It is intended, if means are available, to continue the coöperative survey until the entire State shall be surveyed and mapped.

The topographic work is being conducted under the direction of Mr. T. G. Gerdine, Geographer in Charge, California Work. The report of Mr. Gerdine for the year ended December 31, 1908, is hereto appended:

REPORT OF TOPOGRAPHIC BRANCH.

By R. B. MARSHALL,
Chief Geographer, United States Geological Survey,
By THOS. G. GERDINE,
Geographer in Charge Pacific Division.

We have the honor to make the following detailed report of operations in California, for the Topographic Branch, under the coöperative agreements of May 15, 1907, and June 20, 1908, for the fiscal year ending June 30, 1909:

The detailed topographic survey was continued north on the east side of the Sacramento Valley, beginning where the work was stopped at the end of the coöperative year 1906-7, about on a line east and west through the southern shore of Suisun Bay, or, to be exact, on the thirty-eighth parallel of latitude, and has now reached the thirty-ninth parallel of latitude, which is approximately a line east and west through Wheatland. By the end of the fiscal year 1908 (June 30, 1909) all of the above specified area, extending from the Sacramento River to the 300-foot contour running along the edge of the hills east of the river, will have been completed. This, with the previously completed portion of the Sacramento Valley, which includes all the western part of the valley below the 300-foot contour lying between Red Bluff and Suisun Bay, will complete a survey of four fifths of all the valley lands which are susceptible to irrigation under the proposed dam of Iron Canyon, 300 feet above sea level.

The area has been published, as have the other coöperative surveys in the Sacramento Valley, by photolithography on the field scale of 1:31680, or two inches to one mile, with 5-foot contour intervals, each sheet covering an area of about 150 square miles; and the area west of the Sacramento River has been engraved in standard 15-minute quadrangles of about 240 square miles on a scale of 1:62500 with 10-foot contours. The area east of the Sacramento River will be engraved in 7-½ minute quadrangles on the field scale 1:31680, or two inches to the mile, with 5-foot contours, each sheet covering an area of about 60 square miles.

The photolithographs are published primarily for the use of engineers and it is believed in adopting the new scale for engraving that a more useful map, not only to engineers but to the public, will be published which will present all the information necessary in planning in detail for any form of irrigation, railroad development, drainage or construction of county roads, maps, etc.

The horizontal control was determined by triangulation and primary traverse, and the vertical control by level lines, all in closed circuits. The maps are surveyed by the planetable stadia method, using alidade levels for all points obtained in determining the positions of the contours. These positions average about one hundred to the square mile and are preserved on tracing linen sheets, that can be reproduced by transparent negative sheets to fit over the photolithograph, for the use of engineers. All public land lines, houses, roads, railroads, water courses, etc., are shown.

A detailed tracing is made, showing the land classification as to quality of soil as it appears on the surface to the engineer, the kind of crops produced at the time of the survey; also a careful line is traced showing the edge of the overflow and timbered areas.

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PIERS.

Since the report to January 1, 1907, no additional work has been carried on in the establishment of the chain of concrete piers which at that time had been set along the Sacramento River from Collinsville and Antioch to Sacramento. It is recommended that the erection of these monuments be continued along the river from Sacramento to Tehama, from Vernon to Marysville, and from Antioch along the San Joaquin River to the Southern Pacific crossing.

SALINAS VALLEY.

Owing to the urgent demands for topographic maps in the Salinas Valley, and in order that the work could be used in connection with future irrigation development of this valley, detailed coöperative surveys have been started in the vicinity of Salinas By the end of the fiscal year 1908 (June 30, 1909), the Salinas 15-minute quadrangle will have been completed. This quadrangle is being mapped on a scale of 1:31680 with 5-foot contours, and includes all of the valley lying between Castroville and Chualar, containing about 240 square miles.

IN THE SIERRA.

Problems regarding the storage of water and the protection of the forests, to preserve a steady flow of the streams, becomes of more vital importance to the State of California each year. This is especially emphasized by the recent development of power plants and in problems relating to irrigation and reclamation. For these reasons also the demand for maps of the forest, which will show the extent of the forested area and catchment basins, the lakes and possible reservoir sites, the mapping of the Mariposa sheet in the western and the Mount Goddard sheet in the eastern part of the Sierra National Forest was prosecuted in coöperation during the present fiscal year. It is expected that these sheets will be completed during another field season.

The maps show the topographic features of the land, such as mountains, hills, valleys and gulches; all bodies of water, such as lakes, marshes, streams, and springs; the routes of travel, such as railroads, wagon roads, and trails, political boundaries; cities, towns, and permanent buildings; and the names of natural and other features. They also indicate exactly the location of permanent survey monuments and bench marks, whose positions and whose elevations above sea level have been determined by precise methods—monuments that are available as starting points for local surveys. The maps of areas covered by public land surveys show all township and section lines, as well as the boundaries of all land grants.

To the State these maps are valuable in connection with making coöperative agreements with the United States Geological Survey or with other Government bureaus, for making State geological or other surveys, for use in State Agricultural colleges, in good-roads investigations, in connection with legislation involving county or town boundary lines, or regarding granting of charters, rights, etc., where a physical knowledge of the country is desirable or necessary. Engineers find the maps of service as preliminary surveys for locations of railroads, canals, highways, trolley lines, etc.; for providing water supply for municipal use or for power; in connection with problems involving land drainage and irrigation and for sewerage systems. Miners, land investors, travelers, and tourists use the maps as guide maps, which fully represent local conditions, and educational and scientific institutions utilize them in their various courses of scientific study.

The conditions in California, especially in the San Joaquin and Sacramento valleys, are almost ideal for the construction of detailed contour maps, and when these valleys are completely surveyed, the natural advantages will be shown on the maps in such a manner that it is almost impossible to estimate their worth in the development of the State. The maps present concrete examples of the development in the surveyed areas and on them soil surveys can be shown which will not only solve many questions now daily answered by the local committees and railroad agents, but will illustrate the wonderful possibilities of this region.

RESULTS OBTAINED BETWEEN THE EARLY SPRING OF 1907 AND JANUARY 1, 1909.

Counties.	Quadrangles.	Scale.	Area Mapped.	Spirit Levels.		Trigonometric Locations.	Primary Traverse.	
				Miles.	Bench Marks.		Miles.	Permanent Marks.
San Joaquin	Stockton	1:31680		14	3			
Solano, Sacramento, Contra Costa, San Joaquin	Rio Vista	1:31680		31	7	2	2	
Sacramento, San Joaquin	Woodbridge	1:31680	235	72	9	7	27	
Sacramento, San Joaquin	Lockeford	1:31680	235	62	10	10		
San Joaquin, Amador, Sacramento	Hatchville	1:31680	234	94	16	10		
Sacramento, San Joaquin	Galt	1:31680	234	63	7	4	15	
Sacramento, Placer, Sutter	Fairoaks	1:31680	233	80	17	4		
Sacramento, Placer, Eldorado	Folsom	1:31680	98	51	15	4		
Placer, Eldorado	Auburn	1:31680		34	12	1		
Placer, Sutter, Yuba	Lincoln	1:31680	232	66	21	8		
Yuba, Sutter, Yolo	Knights Landing	1:31680	205	54	6	5		
Placer, Nevada, Yuba	Wheatland	1:31680	72	48	16	11	17	4
Yuba, Sutter	Yuba City	1:31680		67	13	5	34	5
Sutter, Colusa, Yolo	Dunnigan	1:21680		26	5			
Sutter, Colusa	Grimes	1:31680		28	7	1	78	10
Yuba, Sutter, Butte	Biggs	1:31880				9		
Monterey *	Salinas	1:31680	240	94	24	8		
Monterey, San Benito, Santa Clara, Santa Cruz	Monterey			46	16			
Alameda, Santa Clara, Santa Cruz, San Mateo	Santa Cruz			25	4			
Alameda, Santa Clara, Santa Cruz	San Jose			71	16			
Mariposa, Madera, Fresno	Mariposa	1:96000		150	30	15		
Fresno, Mono, Inyo	Mount Goddard	1:96000	355					
Totals			2,373	1,176	254	104	173	19

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* Will be obtained by June 30, 1909.

The State will have expended in the last two years $30,000, the United States Geological Survey $30,000, a total of $60,000, fully ninety per cent of which has been paid to merchants and employees within the State. Therefore, the State has not only received $30,000 from the National Government, but has received 2,400 square miles of careful survey with 1,200 miles of precise level lines, which are permanent in character and will have a constantly increasing value in developing its resources and which in the instances of the Sacramento and Salinas valleys would not otherwise have been surveyed by the National Government in such detail and could not have been mapped by the State for less than double the amount it has cost the State.

CONCLUSION.

It is believed that the importance of this coöperative work can not be overestimated in its connection with the general development of the State, and particularly from an irrigation point of view. It is earnestly hoped that the legislature will fully appreciate its importance and continue the work until all the forest areas and the Great Valley of California has been completely mapped.

R. B. MARSHALL,
Chief Geographer.
THOMAS. G. GERDINE,
Geogropher in Charge Pacific Division.

B.

WATER SUPPLY INVESTIGATION.

This branch of the work of the United States Geological Survey consists of the collection of data concerning the flow of surface waters, and the conditions affecting their flow, underground water supplies, duration, and magnitude of floods, overflow areas, evaporation, rainfall, water power, conservation and utilization of water resources, etc.

The legislature by act approved March 16, 1903, provided for the coöperation of the State with the United States Geological Survey in its investigations and appropriated funds therefor. This policy has been continued by acts approved March 18, 1905, and March 11, 1907.

Stream Gauging.—In pursuit of investigations on this subject more than 70 gauging stations have been maintained on the streams of the State, and the water flowing at all seasons measured.

In the summer of 1905 the streams throughout the State, north of Tehachapi reached the lowest stage known since systematic observations commenced, and as the low water flow is a strong controlling factor in developing irrigation and power enterprises, the opportunity was seized to obtain reliable records of the conditions. The spring of 1904 witnessed an unusual flood in the streams of the Sacramento Valley, and the records obtained were used by the Board of Engineers employed to investigate river and flood conditions of the Sacramento Valley as a basis for their recommendations of a plan for flood control and reclamation in the valley.

Exceptionally heavy snows in the southern Sierras in the winter of 1905 resulted in unusually high waters, flooding the San Joaquin Valley in the following spring. Although the service was not as well prepared there as in the Sacramento Basin, yet the records obtained will be useful in future studies.

In March, 1907, the State was visited by one of the most destructive floods in its history. The magnitude of this flood greatly exceeded the maximum considered by the Board of Engineers above mentioned, and the value of the records obtained by measuring the streams during the height of the flow far outweighs all that it has cost the State to maintain the coöperative investigations.

A report of the coöperative work in relation to surface waters made under the direction of Mr. W. B. Clapp, District Engineer, United States Geological Survey, is published herewith:

PROGRESS REPORT OF THE WATER RESOURCES BRANCH OF THE UNITED STATES GEOLOGICAL SURVEY.

In Coöperation with the State of California.

I have the honor to submit the following report of progress during the past two years in the work of the Water Resources Branch (formerly Hydrographic Branch) of the United States Geological Survey in coöperation with the State of California. This work has been executed in accordance with the legislative acts providing for State coöperation, approved March 16, 1903, March 18, 1905, and March 11, 1907, under which the State and Federal Government has each contributed an equal sum of money.

The hydrographic work proper of the Water Resources Branch comprehends an extensive study of both surface and underground waters as regards source, occurrence, distribution, accessibility, quality, utilization, etc., but this report is concerned with only the surface waters as they appear in the streams and lakes. During the past two years the collection of data relating to the surface waters and a study of the conditions affecting stream flow have been continued throughout the State. Precipitation records in the different stream basins have been and are being compiled, so far as available for purposes of comparison with the measured run-off from the same areas. The United States Weather Bureau has willingly coöperated to the extent of establishing new stations in several localities, particularly at the higher elevations in basins with deficient precipitation records. Some data on evaporation from lake surfaces have also been collected and compiled. Considerable data of exceptional value on the floods of the State, particularly in the Sacramento and San Joaquin basins, have been collected and analyzed. Special reference to the disastrous flood of March, 1907, will be made farther on in this report. Reconnoissances have been made regarding possible storage reservoir sites for various commercial purposes. Compilations are being made of the developed water powers in the State, and also computations and estimates of the great potential water power now going to waste through the channels of unharnessed streams. In all these investigations the aim has been to determine the surface water resources with a view to their greater utilization in the material advancement of the State.

The physical features of the State are such as to divide it naturally into several distinct and pronounced drainage basins. The largest and most important one of these is the Central Basin, with an area of about 64,000 square miles, or 40 per cent of the total area of the State. This basin receives almost its entire water supply from the western slope of the Sierra Nevada and drains into San Francisco Bay through the Sacramento and San Joaquin River systems. The North Pacific Basin contains about 20,000 square miles and has several large rivers. The South Pacific Basin contains about 23,000 square miles and has no large rivers, but most of the streams are quite important. The rest of the State, amounting to about 51,000 square miles, may be classified as part of the Great Interior and the Colorado River basins. This latter area includes all drainage eastward from the Sierra Nevada and the mountains of southern California. Gauging stations are now being maintained in all the basins, except the North Pacific. The list is as follows:

San Francisco Bay Drainage.

Sacramento River System.

Stream.	*Location.*	*Stream.*	*Location.*
1. Sacramento River	Near Red Bluff	8. Yuba River	Near Smartsville
2. Pit River	Near Bieber	9. Bear River	Near Sheridan
3. Cottonwood Creek	Near Ono	10. Cache Creek	Near Lower Lake
4. Stony Creek	Near Fruto	11. Cache Creek	Near Yolo
5. Feather River	Near Prattville	12. American River	Near Fair Oaks
6. Feather River	Near Oroville	13. Puta Creek	Near Winters
7. Indian Creek	Near Crescent Mills		

San Joaquin River System.

Stream.	*Location.*	*Stream.*	*Location.*
1. San Joaquin River	Near Pollasky	10. Modesto Canal	Near La Grange
2. Tule River	Near Porterville	11. Turlock Canal	Near La Grange
3. Kaweah River	Near Three Rivers	12. Stanislaus River	Near Knight's Ferry
4. Kings River	Near Sanger	13. Stanislaus Canal	Near Knight's Ferry
5. Merced River	Near Yosemite	14. Calaveras River	Near Jenny Lind
6. Merced River	Near Merced Falls	15. Mokelumne River	Near Clements
7. Tenaya Creek	Near Yosemite	16. Cosumnes River	Near Michigan Bar
8. Yosemite Creek	Near Yosemite	17. Tulare Lake	Near Lemoore
9. Toulumne River	Near La Grange		

South Pacific Drainage.

Stream.	*Location.*	*Stream.*	*Location.*
1. Arroyo Seco Creek	Near Soledad	7. Santa Ysabel River	Near San Pasqual Valley
2. Santa Ynez River	Near Santa Barbara	8. San Diego River	Near Lakeside
3. Santa Ynez River	Near Lompoc	9. Sweetwater River	Near Descanso
4. San Gabriel River	Near Azusa	10. Cottonwood Creek	Barrett Dam, near Jamul
5. Santa Ana River	Near Mentone	11. Pine Creek	Barrett Dam, near Jamul
6. San Luis Rey River	Near Pala		

Great Interior Drainage.

Owens River System.

Stream.	*Location.*	*Stream.*	*Location.*
1. Owens River	Near Round Valley	13. Sawmill (Eight-Mile Creek)	Near Independence
2. Owens River	Near Tinemaha	14. Oak Creek	Near Independence
3. Rock Creek	Near Round Valley	15. Independence Creek	Near Independence
4. Pine Creek	Near Round Valley	16. Shepard Creek	Near Thebe
5. Bishop Creek	Near Bishop	17. Bairs (Moffett) Creek	Near Independence
6. Baker Creek	Near Big Pine	18. George Creek	Near Thebe
7. Birch Creek	Near Tinemaha	19. Lone Pine Creek	Near Lone Pine
8. Big Pine Creek	Big Pine	20. Tuttle Creek	Near Lone Pine
9. Tinemaha Creek	Tinemaha	21. Cottonwood Creek	Near Olancha
10. Taboose Creek	Tibbetts	22. Ash Creek	Near Olancha
11. Goodale Creek	Tibbetts		
12. Division Creek	Tibbetts		

Colorado River Drainage.

Stream.	*Location.*	*Stream.*	*Location.*
1. Colorado River	Near Yuma, Arizona	2. Salton Sea	Near Salton (Mecca P. O).

At all the gauging stations measurements of flow are made from time to time and at various stages of the stream and a record is kept of the daily gauge heights. The discharge measurements are used to construct a rating curve for the stream from which a rating table is prepared. The table gives the discharge for all gauge heights covered by the annual range of stage. By applying the table to the daily gauge heights the daily discharges are obtained. The results for any one stream are summarized in a table showing the maximum, the minimum, and the mean discharge in second-feet and the total in acre-feet for each month and for the year. The run-off is also expressed in second-feet per square mile of drainage area above the station, and as depth in inches applied to the entire basin. These latter figures are useful in comparing the relative intensity of run-off in different basins, and also for comparing the run-off with the precipitation in each basin. In every case the foregoing data are accompanied by a brief description of the drainage basin and of the station where measurements are made, in order that they may be the more intelligently interpreted and utilized. All these data for the different streams are finally assembled in one volume and published annually by the United States Geological Survey as a Water Supply and Irrigation Paper, the publication being a progress report on the surface water supply of California. No other state in the Union has a separate report of this kind. The report of 1907, however, has not been published and will not be until after all of the data for 1908 shall have been compiled. The two years' work will then appear in one publication. These reports are for free distribution and may be obtained by application to the Director of the Geological Survey at Washington, D. C.

During the last two years there has been no extremely low water, such as occurred in the summer of 1905. The summer of 1908, however, has been characterized by moderately low water, especially in the Sacramento basin, but no unusual records have been established. For this reason no measurements of low water flow in the mountains have been made since the last report. The large number of low water measurements made throughout the mountains of the Sacramento and San Joaquin basins during the summer of 1905, and previous years have been exceedingly valuable in computations for estimates of the potential water power in the State.

While no extremely low water has occurred during the past two years, there have been some very high stages in practically all the streams in the State. During the winter and spring of 1907, great damage was wrought by general floods. In many localities the damage was greater than had occurred for many years previous; in others, it was the greatest on record. The Sacramento and San Joaquin valleys suffered most. In March, 1907, they were visited by one of the most destructive floods on record, especially so far as financial loss was concerned. The Lower Sacramento River and its two larger tributaries, Feather and American rivers reached the highest stages ever recorded, and record stages were reached by other tributaries.

This flood was remarkable in many respects. In the first place, it was preceded by a period of serious flood conditions caused by heavy precipitation, which had prevailed for several preceding weeks. The earth was already saturated and the flood basins in the valleys were already full. Then followed a period of general precipitation of extraordinary intensity, which prevailed for several consecutive days throughout the entire drainage basin. The storm was accompanied by comparatively high temperature, and consequently rapid melting of snow in the mountains. The Lower Sacramento, Feather, Yuba, and American rivers not only reached the highest stages ever recorded, but they maintained these stages for a moderately long period. Simultaneously with these, all the other streams maintained high stages, and the combined effect was a flood of exceptional height and extent, and of considerable duration. For the four days, March 18th to 21st, the mean rate of flow from the mountains and foothills of the Sacramento Basin alone was about 530,000 second-feet, or more than 22 second-feet per square mile.

During and after the flood, special effort was made to get all the data possible. Nearly all the important tributaries of both the Sacramento and San Joaquin River systems were gauged. The flow from 83 per cent of the mountains and foothills in the Sacramento Basin was measured at eleven stations, and the flow of 41 per cent of the mountains and foothills in the San Joaquin Basin was measured at six stations.

Unfortunately, no gaugings of the San Joaquin itself were made, as no station had been established at that date. Since that time, however, a station has been established near Pollasky.

It is believed that the data obtained during this flood are of sufficient value to fully compensate the State for its generous coöperation with the United States Geological Survey in the study of its water resources. Data are now available for planning a more comprehensive reclamation system for the Sacramento and San Joaquin valleys than has been possible heretofore. The importance of the data now available will be appreciated when it is recalled that the rate of inflow into the Sacramento Valley alone for four successive days, March 18th and 21st, was 112 per cent greater than the rate assumed as a maximum by the 1904 Commission of Engineers, after an exhaustive study of all flood data on record, including those of 1904 flood. Undoubtedly they will be of the highest value in the solution of the intricate reclamation and flood problems to be encountered in the future development of the valley.

At the time of making the last report, the old Tulare Lake bed had just been recently flooded. The first water entered March 15, 1906. The lake level continued to rise until August 4, when the lake had a maximum depth of 12.5 feet, and submerged about 300 square miles. After this date, the water slowly subsided until December 9th, when it began to rise again and continued to do so until July, 1907, when it had a depth of about 14 feet. Since the latter date it has steadily lowered. The exact figures are not yet compiled, but the lake probably has a depth of about 10 feet and an area of about 200 square miles.

It was believed, at the time of the last report, that Salton Sea had reached its greatest depth, but such proved not to be true. Owing to another break in the Colorado River, the sea continued to rise until February, 1907, when it had a maximum depth of 75 feet and submerged an area of about 500 square miles. During the rest of 1907 the water surface lowered 3.7 feet. The inflow from Imperial Valley is considerable, especially in the middle of the irrigation season. In order to determine its quantity, a large number of measurements were made during the first seven months of 1908. Notwithstanding the large inflow, the water surface lowered 4.4 feet during the first ten months of 1908. In November, the sea covered nearly 450 square miles, and had a maximum depth of about 68 feet. Under the supervision of the Weather Bureau and in coöperation with the Water Resources Branch of the United States Geological Survey and the Reclamation Service, an especially equipped evaporation station is being installed for the purpose of studying evaporation from the surface of a large body of water in an arid desert.

During the past two years, several gauging stations have been abandoned in localities where the records have been kept long enough to satisfy the local demand, or where the cost of maintenance was deemed excessive, compared with the value of the results obtained. On the other hand, several new stations have been established on other important streams where greater benefits will accrue to the public. The controlling principle of action in all such cases is that of rendering the greatest service to the greatest number, commensurate with the money expended. Most of the stations maintained at the present time should be continued for several years yet, as the value of the records enhance with their length and continuity. There is need of some new stations in different parts of the State, especially in the North Pacific Basin where no stations are maintained at the present time, but no material extension of the work is possible with the funds now available.

The increasing demand for authentic hydrographic data is the best index of the public interest in the present study of the State's water resources. Frequent requests for stream flow data come from many localities throughout the State. These data are being used as the basis for irrigation enterprises, power developments, and municipal water supplies, and they are invariably accepted by both parties in adjusting conflicting water rights. The relation of the agricultural, industrial and commercial advancement of the State to the water supply—its quantity, distribution, and accessibility—is becoming more fully understood, and it is certain that the future will witness a great demand for all the hydrographic data obtainable.

W. B. CLAPP,
District Engineer.

UNDERGROUND WATER RESOURCES IN SOUTHERN CALIFORNIA.

Practically every drop of surface water is utilized and great attention is given to the development of underground water. Some communities seem to be outgrowing the possibilities of such development; therefore, the survey has devoted special attention to the study of underground supplies in those regions.

The result of this work, conducted by Mr. W. C. Mendenhall, geologist in charge of underground water investigation, is published in Water-Supply Paper No. 219, entitled Ground Waters and Irrigation Enterprises in the Foothill Belt, Southern California, 1908.

In this report, which is a volume of 180 pages, with numerous maps and diagrams, Mr. Mendenhall gives an elaborate history of the development of irrigation in that region, and treats of the serious shrinkage of the artesian area within the last two decades, of the lowering of the groundwater level, and discusses the causes of the same. This report may be had by application to the Director United States Geological Survey, Washington, D. C.

In the San Joaquin Valley all of the normal flow of surface water has been appropriated, and even the surplus flood waters, which uncontrolled as they are, can do naught but damage in their race to the sea, are claimed as "property" by certain wealthy riparian owners. Instances are on record where would-be appropriators have constructed expensive works and in their notices of appropriation have specifically declared that they only claim the surplus waters and recognize all prior rights, nevertheless they have been stopped by injunctions, the riparian owners setting up the theory (implied) that it is their own business if they shall be injured, and they are entitled to all the benefits (as well as the damages) that can accrue from their position as bank owners.

The area of the San Joaquin Valley floor is about 7,360,000 acres. The average yearly discharge of water into the valley from all of the streams entering it is about 11,500,000 acre-feet, or enough to cover the entire flow of the valley one foot and seven inches in depth.

Under the wasteful methods used for irrigating from gravity systems, two or three times as much water is used as the above supply would furnish, even if it were all conserved and distributed.

In consequence of the limit having been practically reached for acquisition of surface waters, the unirrigated arid lands must be reclaimed by drawing from the underground supply.

The recent rapid extension of agricultural development in the southern San Joaquin Valley, outstripping the available surface water supply, created an urgent need for accurate information as to the occurence and accessibility of subterranean streams and reservoirs. The Reclamation Service in its search for available reclamation project made some investigations in the valley, but without promise of results, as its energies were concentrated upon other localities which seemed more practicable and the work here was abandoned. The work of the Reclamation Service, however, had furnished some idea of the extent, accessibility, and quality of the underground waters in many parts of the Valley. The continuation of this work was taken up by the Water Resources Branch of the United States Geological Survey, under the coöperative agreement with the State, and in the spring of 1905 parties were assigned to work in this field, who collected some preliminary data, but the funds available were not sufficient to enable the work to be carried on continuously or systematically, so it was suspended in July. Field work was again commenced in the spring of 1906 and continued through the summer of 1907.

Considerable information has been obtained in regard to artesian wells, domestic wells, and pumping plants, as well as the geologic structure of the foothills and their relation to the distribution of the water bearing soils of the valley.

The artesian belt, so called, within which it may reasonably be expected flowing water may be obtained, begins at a point in the southern portion of the valley, about twenty-five miles west of Bakersfield, and extends along both sides of the trough of the valley in varying widths to the junction of the San Joaquin and Sacramento valleys. A small, apparently isolated, area of some 180 square miles, lying south of Bakersfield embraces the former beds of Buena Vista and Kern lakes. The total area of this great artesian belt is about 4,300 square miles. Not all of the artesian water developed within this area is suitable for irrigation, nor does there seem to be any line defining the boundaries of territories yielding pure or impure waters. At least the investigations have not determined such boundaries as yet. In addition to the artesian water shown to be available, the entire floor of the valley is underlaid with water bearing strata, lying at varying depths below the surface.

Pumping, to a limited extent, has obtained throughout the entire valley. The water raised by pumps is used for irrigation, city supply, and for steam boilers. The most extensive use for steaming purposes is at the oil-drilling and pumping plants in the oil fields and the high duty pumping stations along the oil pipe lines to the coast.

In Kern County, more than one hundred pumping plants are installed. Of these, above 40 per cent are gas-engine plants, using gasoline or distillate, 25 per cent are steam plants, and the remainder are operated by electricity. Most of the irrigating plants use centrifugal pumps. In Tulare County, along the eastern edge of the valley, are the famous orange orchards of Portersville, Lindsay, and Lemon Cove. Near Exeter, Tulare County, is found the highest lift yet recorded for an irrigation pumping plant, five hundred eighty-six (586) feet. It goes without saying that none but an orange orchard could pay the price for raising water to such a height.

In the citrous belt of Tulare County, about two hundred pumping plants are in operation, 65 per cent being electric-driven and 35 per cent operated by gas engines or steam.

The range of lift from the water surface to the surface of the ground is from 0 to 100 feet. The ground water level varies greatly during the season. For lifts exceeding 75 or 80 feet deep-well plunger pumps are used instead of centrifugals.

In Kings County are found some of the most reliable gravity systems in the valley, but they do not reach more than 40 per cent of the irrigable lands of the county. The bed of Tulare Lake from which the water has receded has become veritable "desert land," but with water applied is very productive. Since but little surface water is available recourse is had to wells. There are about 100 flowing artesian wells in the county, the greater portion of which are in or near the old lake bed. The flow of some wells is augmented by pumping. Some non-flowing wells, too, are pumped, the power used being steam or gas engines.

The most highly developed part of Fresno County is east of the trough of the valley surrounding Fresno City, and has been made populous and prosperous through the agency of its splendid canal system, which brings water from Kings River.

Only about forty flowing artesian wells have been bored. They are scattered over sparsely settled country of large ranches and are not much used for irrigation.

Madera County has about thirty flowing wells, practically all being used for watering stock. In the vicinity of Borden subsurface waters are pumped from fifteen or twenty wells and used for irrigation. The water table here is 10 to 20 feet below the surface of the ground but the pumps usually lower the water 15 to 20 feet so the total lift ranges from 20 to 40 feet.

Some irrigation is done from canals from the Fresno and Chowchilla rivers, two small, intermittent streams, very erratic in their flow.

Merced County is better supplied by irrigation, both surface and ground water supplies, than is Madera County. There are between 125 and 150 flowing wells in the county, but nearly all are used for stock purposes rather than for irrigation. Outside of the artesian belt some fifty pumping plants are in operation—about half for irrigation, the remainder for domestic and town supplies.

Stanislaus has done but little toward utilizing ground-water resources. The Turlock and Modesto Irrigation District systems and the canals along the San Joaquin River furnish a very reliable source for irrigation. Not more than a half-dozen flowing wells are in the county, and only one is known to be used for irrigation. Ground water is accessible, with moderate lifts, over a large part of the county and will eventually be utilized.

San Joaquin County has not done much to develop her artesian supply. In and around Stockton are several flowing wells of great depth. Some furnish excellent water while others are so strongly mineral that the water is used only for bathing. A number of deep wells have been bored, solely to obtain natural gas, which they produce in abundance. Ground water in abundance is found at shallow depths. A large number of small pumping plants are in operation and their number is being constantly increased.

The possibilities of the development of underground waters throughout the San Joaquin Valley are very great, and it would seem that by adopting intensive farming to compensate for the expense, the territory will be able to support a large and prosperous population.

Water Supply Paper No. 222, entitled "Preliminary Report on the Ground Waters of San Joaquin Valley, California," by W. C. Mendenhall, 1908, covers the investigations made to the close of 1907.

The third region to receive attention in the matter of investigation of underground water resources is the Colorado Desert, particularly in Imperial Valley and about the Salton Sea. In the northern end of the valley ground waters have been developed and through their agency several thousand acres of desert have been reclaimed and placed under intensive cultivation.

The coöperative arrangement with the State has enabled extensive studies of the extent and permanence of the artesian belt of the desert and Imperial Valley, the results of which will soon be issued in printed form.

The report of underground water investigation, conducted by Mr. W. C. Mendenhall, geologist in charge, is published herewith.

PROGRESS REPORT ON UNDERGROUND WATER RESOURCES UNITED STATES GEOLOGICAL SURVEY.

WATER RESOURCES BRANCH,
WASHINGTON, D. C., December 1, 1908.

Department of Engineering, Sacramento, California.

GENTLEMEN: I have the honor to submit the following statement of work done during the past year in California by that division of the Water Resources Branch of the United States Geological Survey that has to do especially with Ground Water Investigations.

The work has been carried out as heretofore by a coöperative agreement between your honorable body and the United States Geological Survey. The thirty-seventh session of the legislature of California in 1907 appropriated $20,000 from the State funds for the investigation of the Water Resources of the State of California. This sum was met by an equal allotment by the United States Geological Survey. Of this total of $40,000 for two years or $20,000 per year, about 25 per cent was set aside for the study of the Ground Water Resources. As a result of this expenditure of $5,000 annually, the investigations reported to you one year ago as under way in the foothill belt of Southern California have been completed and a report has been issued upon this field and is now available for distribution to those of the citizens of California who may be interested. It is known as "Water Supply Paper No. 219" and may be secured by application to the Director, United States Geological Survey, Washington, D. C., or to the Department of Engineering, Sacramento, California.

The studies under way in the San Joaquin Valley where ground waters exist in great quantities and are easily accessible, have not yet been completed but a preliminary report in which such results as are now available have been assembled, has been issued as "Water Supply Paper No. 222." Eventually a more complete report, embodying engineering and purity data that were not available at the time of the preparation of the report issued, will be prepared.

A third report, under way one year ago, has likewise been completed but is not quite ready for distribution. This contains the results of a study of ground water conditions in the Colorado Desert, particular attention having been paid to the artesian basin of the northwestern arm of the desert known as the Coachella Valley. This report, which will be issued as "Water Supply Paper No. 225," will probably be available for the use of the citizens of California early in the year 1909.

The measurements of fluctuations in the level of the ground waters in the important valleys of Southern California, measurements that have been underway for some years past, have been continued under the present coöperative agreement. This part of the state includes the section in which developments of ground waters have been more intense than anywhere else in the Union. Practically all of the irrigations systems that depend primarily upon surface waters for their supply have subsidiary pumping plants, by whose use the necessary supply during the dry season is maintained. So large a capital is invested in the citrus industry in Southern California, and the dependence of this industry upon the ground water supply is so direct, that it has long been evident that more complete evidence than has heretofore been available of the effect of ground water developments upon the under ground supply is desirable. It is to obtain this evidence that these fluctuation measurements were undertaken in 1904 and have been continued to the present. The results of measurements during the years 1907 and 1908 will be submitted for publication about June 1, 1909, and should be available within a few months thereafter.

Two new researches have been undertaken within California during the current year by the use of the coöperative fund. One of these is an investigation of the springs of the State. With the State's increasing recognition as a tourist center, these springs are becoming better and better known as health resorts, and the demand for definite information about them is growing correspondingly. It is to meet this demand that a geologist has been placed in the field, who will examine each of the important watering places of the State and gather authoritative data as to the temperature and quantity of the water and origin of the springs, and eventually make this material available to the citizens of California in the form of a published report.

The second new research within the State is an investigation of the underground waters of the Mojave Desert, lying immediately north of the Sierra Madre and San Bernardino Mountain ranges. It has long been known that in the southern end of this desert certain areas exist in which flowing waters can be secured, and the increasing demand for agricultural lands in California results in a constantly growing interest in the possibility of agricultural development in this section. A careful examination of the conditions which control the occurrence of the underground waters, with a mapping of flowing well areas and of the ground water levels has been undertaken. All of this data will be published with descriptive text and so will become available to the citizens of the State, as studies of other sections have been made available in the past.

Yours very respectfully,

W. C. MENDENHALL,
Geologist in charge Ground Water Investigations.

C.

HYDRO-ECONOMIC.

Inquiry under this head is for the purpose of acquiring information of the quality and purity of the waters of the State for economic uses and the variation from day to day and from season to season of the amount and nature of the ingredients carried in solution or suspension

The investigations being pursued are gathering data upon the following specific subjects:

(*a*). *Sources of water supply best adapted to municipal uses.* Water derived from different geological formations differ widely in their chemical constituents. Some are pure, in a potable sense; others are impregnated with minerals dissolved from the rocks they have passed over, and often to such an extent as to render them wholly unfit for municipal purposes. These investigations in which the State is coöperating will show which waters may be used and which should be avoided.

(*b*). *What waters may be adapted for irrigation.* Some waters contain such quantities of ingredients harmful to plant life that they must be avoided. Others, though containing harmful matters, may be used without harm if properly applied. Probably almost every natural water of California, which is in sufficient quantity for the purpose, may be used for irrigation, if used intelligently. Water containing alkalis in deleterious quantities for some lands may be used with advantage on others, and possibly on both by scientific methods adapted to the conditions.

(*c*). *What waters may be used for industrial purposes.* Many waters are harmful to steam apparatus. The State owns and operates a number of steam plants at its various public institutions, and some of them have trouble on account of the non-adaptability of the water used for the purposes required. More institutions will be established and the State should know what to provide for.

Water suitable for one line of manufacturing may be wholly unsuited for another. The State and Nation, coöperating, should acquire this information for the people and have it ready at hand when needed to guide the establishment of industrial enterprises.

(*d*). *Where systems of water purification may be employed, and the best systems to install for a particular quality of water.* Sacramento City affords an example of the needs of just this kind of investigation. Here is a large city, the capital of the State, arrived at the point where she must provide her people with a supply of pure water, and the need is so pressing that she can not wait for the collection and promulgation of data on the question, but is driven to the necessity of spending large sums in making independent investigations. The State in coöperation with the Federal Government, should acquire this information for all its communities at as early a date as practicable.

Owing to the fact that most of the towns and villages of the State are not situated so as to conveniently discharge their sewage into the living streams, the waters of the State are comparatively free from polution from that source. But those cities which do dispose of their sewage in the manner indicated are growing in population, and other towns are being established. Communities are increasing which must use of the polluted waters for domestic purposes, and sooner or later the conditions will demand both that the sewage be rendered innocuous, and that the water supplies be purified.

One method of purification will serve for one or many sources of water, while other types must be treated differently. The object of inquiry along these lines is to afford reliable information that will enable intelligent selection to be made.

(*e*). *Whether the water furnished by a given source may be good at one season and bad at another.* Many streams which gather their supply in regions where the rocks and soil are impregnated with soluble minerals, and traverse low lands where the soil is similar, are known to furnish good water during the flood seasons, but as the stream shrinks to the low water stage the waters become so highly charged as to be unfit for use. When all such streams are recorded with their characteristics, physical and chemical, it will be known where improvement may be made by impounding the good water for use while the bad is allowed to escape.

In selecting waters for the preliminary investigation of this subject the State was divided into three districts as comprising so many types of drainage areas, viz., Sacramento Valley, San Joaquin Valley, and the Coastal Region, and several observation stations were established. It was soon found that the streams of adjacent drainage areas possessed characteristics so nearly in common that the selection of one stream would serve as a type of several. Such was the case in upper San Joaquin Valley. The data secured for Merced, Stanislaus, and Tuolumne rivers were so nearly in accord that it was decided to continue observations only on one, and all of the stations were abandoned excepting the Tuolumne.

At each station daily samples of the water were taken and sent to the laboratory of the United States Geological Survey at Berkeley, where the samples for ten days' collection are combined and analyzed so that the analyses represent the composite for ten-day periods.

The data from each station is carefully studied from every standpoint and the resulting report will show the engineer, city official, manufacturer or farmer whatever advantages or disadvantages any particular supply may possess for the purposes for which he desires to use it.

Up to the close of 1908 more than six hundred (600) analyses have been made, and much of the data collected has been prepared for report, which will probably be ready for publication before the end of the fiscal year.

This coöperative work has been conducted under the direction of Mr. Walton Van Winkle, Assistant Chemist, and the analyses have largely been made by Mr. F. M. Eaton, Assistant Analyst, in the laboratory at Berkeley, California.

The report of the operations for 1907 and 1908 are published herewith:

DEPARTMENT OF THE INTERIOR—UNITED STATES GEOLOGICAL SURVEY.

OFFICE OF THE DIRECTOR,
WASHINGTON, November 28, 1908.

HON. N. ELLERY,
State Engineer, Sacramento, California.

SIR: I have the honor to transmit the following report on the quality of water investigations conducted in coöperation with the State Department of Engineering, by the Water Resources Branch of the United States Geological Survey.

During 1905 and 1906, a series of analyses of river waters was made under coöperative agreement with the object of ascertaining the availability of the supplies for municipal and industrial consumption. Daily samples of water were collected for a period of one year at the following stations in California, and united in sets of ten, and the composites thus obtained were submitted to complete mineral analysis:

San Lorenzo River	At Big Trees.
Mokelumne River	At Clements.
American River	At Fairoaks.
Stanislaus River	At Knights Ferry.
Tuolumne River	At Lagrange.
San Joaquin River	At Lathrop.
Merced River	At Merced Falls.
Alameda River	At Niles.
Sacramento River	Above Sacramento.
Yuba River	At Smartsville.
San Lorenzo River	At Felton.
San Benito River	At Hollister.
Santa Ana River	At Mentone.
San Luis Rey River	At Papa.
Santa Ynez River	At Santa Barbara.
Santa Maria River	At Santa Maria.
Arroyo Seco River	At Soledad.
Kern River	At Bakersfield.
Malibu Creek	At Calabasas.

The analytical work was performed by F. M. Eaton, assistant analyst, United States Geological Survey, in the laboratory at Berkeley, and his report on the rivers is now nearing completion.

In 1907, coöperative studies were again commenced to ascertain the quality of the surface waters of the State in special reference to their industrial value. Active field work was commenced in October, 1907, by Walton Van Winkle, Assistant Chemist, United States Geological Survey, whose report on the present status of this investigation is quoted:

"In inaugurating the investigation of 1907, the work previously performed was thoroughly reviewed and a basis for the new examination was determined. Owing to their low mineral content, the waters flowing directly from the Sierras were omitted for further consideration except in so far as a knowledge of their seasonal changes would aid in interpreting analyses of streams which they feed. In the southern part of the State, in the irrigated districts, an accurate knowledge of the quality of the waters seems to be desirable, especially in regard to the effect of seepage and drainage occasioned by irrigation and other uses. It was evident that the problem of irrigation in Salinas Valley could not be solved with exactness without detailed knowledge of the quality of waters in that district. Accordingly, due stress was laid upon these phases of the study. In order to increase the knowledge regarding the general characteristics of the surface waters, the investigation was widened out from these centers so that practically every drainage region is included. With the funds available, only the larger streams could be examined, and as a result the problems attacked are very broad.

Collectors were appointed at the following places to make daily samplings of the water, and to forward them to the Berkeley laboratory for examination:

Stream.	Place.	Collector.
Cache Creek	Yolo	Mrs. C. W. Bigelow.
Cottonwood Creek	Above San Diego	Southern Cal. Mountain Water Co.
Estrella River	Near San Miguel	J. A. Journey.
Nacimiento River	Nacimiento Ranch	A. F. Fenton.
Owens River	Charlies Butte	Roy Bowers.
Owens River	Round Valley	L. Roberts.
Russian River	Ukiah	Gertrude Howard.
Sacramento River	Above Sacramento	Seb. Hemberger.
Salinas River	Paso Robles	C. B. Wieser and J. N. Currell.
San Antonio River	Above Bradley	A. Branch.
San Gabriel River	Azusa	C. S. Woodward, A. Peake, and J. W. Moon.
San Gabriel River	Near Rivera	Mrs. S. E. Pallett.
San Joaquin River	Near Lathrop	O. A. Seamands.
Santa Ana River	Near Corona	Mrs. W. C. Warner.
Santa Ana River	Mentone	Chas. S. Putnam.
Santa Ynez River	Near Santa Barbara	Santa Barbara Water Department.
Santa Ysabel River	San Pasqual Valley	S. F. Potts.
Ventura River	Above Ventura	Ventura County Power Co.

Each of the stations, save that on the Santa Ynez, which was discontinued after about four months' operation, was maintained for one year, the daily samples being combined into ten-day composites and analyzed at the Berkeley Laboratory. Collections were commenced on December 1, 1907, and analytical work was begun the same month.

In addition to these regular stations, seasonal samplings have been made on the following streams, so that their general character may be known and a basis for future detailed work may be obtained.

Stream.	Place.
Carmel River	Above Carmel.
Salinas River	Spreckels Refinery.
San Lorenzo River	King City.
Poncha Reca Creek	San Ardo.
Graviota Creek	Above San Ardo.
Indian Valley Creek	Douglas Ranch.
Cholame Creek	Shandon.
San Juan Creek	Shandon.
Huer Huero Creek	Near Paso Robles.
Mojave River	Victorville.
Eel River	Fortuna.
Mad River	Diversion site.
Pescadero Creek	Hollister.
Otay River	San Diego.

Up to December 31, 1908, slightly over six hundred chemical analyses have been performed, and much of this material has been computed for a report. It is expected that this report will be ready for the printer by the end of the present fiscal year. It will be of great value in giving to the people of the whole State a clever idea of local problems and in aiding in an intelligent, profitable use of surface waters.

Respectfully submitted.

WALTON VAN WINKLE,
Assistant Chemist.

Many local problems of considerable importance have as yet been barely touched upon, owing to the limited funds available. Work is needed along the western tributaries in San Joaquin and Sacramento valleys and in Modoc and Lassen counties. The growing use of irrigation in the Imperial Valley makes it advisable to have more definite knowledge regarding the quality of waters in that region. Mojave River should be examined more fully, with a view toward irrigation possibilities. The vineyard counties should receive attention, as the water problems there are peculiar, though not superficially apparent. Profitable work could be done on the Santa Clara system and in the San Jose district.

Future investigation of the above-mentioned character will require an expenditure of $6,000 during the next two years' period of coöperation; and it is recommended that coöperation to that extent be continued, the State of California and the United States Geological Survey each contributing $3,000 during two years for that purpose.

This will enable the extension of operations, and give all sections of the State due attention. Coupled with the stream flow data, the results of such investigations will make it possible to determine the potability of the waters, their value in industrial processes, and their adaptability in irrigation. The spoiling of arable soils by soaking them with bad waters will be lessened, and thousands of acres will be saved for the farmer. A detailed study of the quality of the subsurface waters will be of extreme value and could undoubtedly be conducted in connection with underground water investigations if a slight increase in funds were available.

Up to and including November 16, 1908, $3,683.50 have been expended in the present quality of water investigation as follows:

Salaries of chemist and assistants	$2,147 69
Traveling expenses	664 19
Supplies and equipment	391 90
Collectors	479 72
Total	$3,683 50
Transferred to California débris investigations from survey allotment of 1908	250 00
	$3,933 50

The projected work for the remainder of the year will expend the balance.

Very respectfully,

H. C. RIZER,
Acting Director.

D.

IRRIGATION INQUIRY.

Under this head coöperative work was commenced in 1905 by Mr. S. Fortier under direction of the Director of the Office of Experiment Stations, Department of Agriculture. The inquiry embraces the following:

(*a*). Investigation of the duty of water used for irrigation and the factors influencing the same.

(*b*). Studies of the preparation of land and the application of water for irrigation with a view of improving methods, both as to efficiency of service and economy of use.

(*c*). Studies of the best methods or organizing communities so as to secure stable supply and equitable and economical distribution of water to users.

(*d*). Studies of the best methods of pumping and the cost of same.

(*e*). Studies of the loss of irrigation water from, seepage, evaporation, wasteful methods of application, etc., and ascertaining the best methods of preventing or lessening such losses.

(*f*). Studies of the need of draining surcharged lands and the most practicable methods of accomplishing same.

The United States Geological Survey, through its hydrographic branch, has been for several years collecting data on the duty of water as related to other lines of investigation. This work is still pursued by the survey incidentally to its work in the several divisions of water-supply inquiry. The office of Experiment Stations of the Department of Agriculture began in 1903 special study of the subject by experimentation and by the collection of information in regard to the practical experience of irrigators.

The subject covers such a wide range of inquiry, including character of soil, climate, regularity of supply, kind of crops, method of application, etc., that it has required a large number of reports and bulletins in which to publish the results of the inquiry.

The preparation of the land is almost as varied in method as the number of localities engaged in irrigation. In the San Joaquin Valley the check system is almost wholly used, especially where the supply is from open canals. The size of the checks has undergone a great change since they were first adopted. In other localities the furrow method obtains, while in still other communities other systems are in vogue. The factors which influence the quantity of water used often prescribe the method of its application. These many methods are described in several publications, among which may be mentioned Bulletin No. 145, entitled, "Preparing Land for Irrigation and Methods of Applying Water, 1904." This treatise gives much detail of methods of leveling and smoothing, checking and furrowing the land, methods and appliances for distributing the water. The work is embellished with illustrations of tools and implements for various purposes as used in different sections of the country.

The studies into the systems of organization best adapted to the needs of the irrigators have not yet been formulated into a comprehensive report, though several publications have been issued dealing with the irrigation laws of different states and countries.

Costs and methods of pumping have been quite thoroughly canvassed and tables prepared for different sections having typical conditions of development and operation.

Most irrigated countries, particularly those older in the practice, find that after a few years they are confronted with the problem of drainage.

In Fresno and Kings counties of this State, where the ground water was 50 or 80 feet below the surface before irrigation was introduced, it has risen so that in many places it has drowned the orchards, and often stands in ponds in the lower depressions of the ground. In many localities the water table has risen, and not only drowned trees and vines, but has brought alkali to the surface. Large tracts of land formerly productive have been rendered valueless in this manner, and must remain so unless reclaimed.

Experiment has demonstrated that such lands can be largely or wholly restored to productiveness by proper drainage. (See bulletins and reports of the experiment stations.)

In commenting upon the loss of water in irrigation enterprises a few years ago a well-known authority estimated that the farmers of the irrigated districts of the United States expended annually $50,000,000 for water and its application to the soil, and that fully 70 per cent was wasted.

It is not possible to prevent all of these losses, but scientific construction of works and rational systems of distribution together with sound methods of administration will transfer a large part of this loss to the other side of the ledger. It is the province of the investigations being conducted by the Office of Experiment Stations in coöperation with the State to ascertain and point out the faults and the remedies therefor, and the results of the inquiries along these lines are published as the data are collected and digested.

A report of the coöperative work accomplished in the last two years herewith follows:

REVIEW OF COÖPERATIVE IRRIGATION AND DRAINAGE INVESTIGATIONS BETWEEN THE STATE OF CALIFORNIA AND THE OFFICE OF EXPERIMENT STATIONS, UNITED STATES DEPARTMENT OF AGRICULTURE.

By F. W. Roeding,
In Charge of California District.

In accordance with the terms of the agreements for the fiscal years 1906-1907 and 1907-1908, between the State of California and the Secretary of the United States Department of Agriculture, relating to coöperative investigations between the former and the Office of Experiment Station, United States Department of Agriculture, the scope of these investigations has been conducted as outlined therein, and this review is to present a condensed statement of the work to date, including the period from November 24, 1906.

On this latter date a report for the year 1905-1906 was presented to the Board of Examiners, State of California, by Dr. S. Fortier, then in charge of the Pacific District, and at present Chief of Irrigation Investigations, United States Department of Agriculture, which not only gave an insight into what had been accomplished up to that time, but also outlined the proposed work. This work has been continued and amplified as occasion arose.

Sacramento Valley. The possibilities of irrigated agriculture in this valley have been realized more strongly than ever during the past few years and a great impetus has been given to its development thereby. Grain farming, which has been its dominent industry, has been practiced so assiduously that the yields, as well as the quality, have declined until there is little or no profit left. The farmers are therefore seeking crops which are productive of greater revenues and must resort to irrigation to improve their condition. A study has been made during the past two years of the larger irrigation systems of the valley, as well as its possibilities for irrigated agriculture, and these studies will be included in a bulletin by Dr. S. Fortier, which is now in press under the title of "Irrigation in the Sacremento Valley."

The territory covered in this bulletin represents the Yolo Consolidated Canal System, which is the oldest in the valley, the Government project and private ditches at Orland, the Central Canal, the Butte and Sutter County Canals, the irrigated districts around Oroville, Thermalito and Palermo, the Sierra Valley country, and the pumping plants near Dixon. Its purpose is to furnish data as to the methods of conducting the affairs of these various canals, the use and duty of water under them, the results of experiments conducted on alfalfa fields and orchards, and a general discussion of the future of irrigation in the Valley.

The University Farm at Davis. Arrangements were made with the authorities of the University whereby 25 acres on the University Farm, recently established at Davis, were turned over to the Irrigation Investigations for experimental purposes. These investigations are to be conducted along practical lines and will include the various methods of preparing land for irrigation, types of small ditch structures, methods of applying water, instruments and means by which the water applied can be measured, time of application and quantity used to give best results on various crops, seepage and evaporation losses in ditches and their prevention through various lining materials, the use of soil tanks in the determination of best methods of conserving the moisture applied to the soil, and a practical demonstration of pumping water from wells. This work is largely educational and its features will be under the observation of the students at the Farm in connection with their irrigation course.

Manuals on Alfalfa, Orchard and Sugar-Beet Irrigation. It has been realized for some time that a practical treatise giving methods pursued in the growing of the more important crops was an absolute necessity not only in improving the methods at present in vogue, but also in furnishing information to new settlers who are unfamiliar with irrigation conditions. A study has therefore been made of the practices followed throughout the irrigated sections of the United States in preparing land, constructing and laying out field laterals and applying water, together with a short account of the various processes connected with the planting, growing, and harvesting of these crops. This information, which has been gathered in every irrigated section, is at present being compiled and will appear in the form of manuals, each one of which will be devoted to a specific crop. In presenting such information, it is hoped that the review of the best practices throughout the country will furnish suggestions by which growers of each crop may profit from experience and methods of other sections, while novices may secure information at once which will aid them very materially. California, as the great fruit producing region, was covered pretty thoroughly, the district including the orange orchards and walnut groves of southern California, and the deciduous orchards of the Sacramento Valley, San Joaquin Valley and Santa Clara Valley. Alfalfa growing and the sugar-beet industry were also investigated in various parts of the State.

Modesto and Turlock Irrigation Districts. The success of these two districts after many trials and tribulations is now assured, and fully justifies the wisdom of the Wright Irrigation Act and its amendments, as passed by the legislature of 1897. The many failures of districts which were organized shortly after the passage of the original act tended to retard any further organizations, but the present management and excellent condition of the two districts mentioned above have led to a revival of interest. A number of communities are preparing to take advantage of the State law, and with the experiences of the older districts as a guide, there is no reason why they should not be successful. This office is in receipt of numerous letters asking for information on this subject, so that investigations have been continued since the report in Bulletin No. 158 of this office. These investigations include seepage losses from canals, the duty of water on various crops, and the management and organization of the districts. The rapid rise of the ground-water throughout both districts, due to the porosity of the soil and excessive use of water, has presented the needs of drainage. The act of the last legislature approved March 18, 1907, permitting an irrigation district to become a drainage district also, whenever the board of directors of that district may decide upon the necessity of such drainage, has been a great help in providing for such work. Canals to relieve the high water table are now in course of construction in both districts, and a study of the effects, as well as the method of drainage, is being made by this office. Mr. V. M. Cone agent of the Irrigation Investigation, has had charge of these investigations during the past two years.

Fresno Drainage. Conditions which must sooner or later be faced by all irrigated sections, due to the rise of the ground-water from unrestricted irrigation, have been realized in the older settled colonies of Fresno County for some time. These lands, which in the period from 1880 to 1890 were the show places of the county and the pioneers of the raisin industry in the United States, have largely become an alkali waste, with the attendant decrease in value, until they are to-day practically worthless. That they could be reclaimed and returned to their former productiveness through drainage was never doubted by this office, but it was necessary to furnish a practical illustration in order to convince skeptics of its value and also to demonstrate that unless some steps were taken the balance of the vineyards and orchards would suffer a similar fate. Through the efforts of the Fresno Chamber of Commerce and the coöperation of Messrs. J. S. Dore and Lusius Baker, both residents and vineyardists in the affected districts, their lands were selected for the experiment. A tile system and pumping plant was installed on each farm during the winter of 1906–7, and the removal of the alkali as well as the lowering of the water table to the depth of the tile commenced. This work has been eminently successful, and a detailed description and study of it, including also drainage investigations in the Modesto-Turlock districts, will appear in a bulletin of this office by Mr. V. M. Cone. The results obtained have led to an increased interest in this subject, not only in the alkali belt, but also on those lands where ground-water is so close to the surface that trees and vines can no longer thrive. The formation of a drainage district under the State law of March 20, 1903, is now contemplated, and it is proposed to include practically all of the irrigated lands between Fresno Slough and the foothills of the Sierras, covering an area of about 230,000 acres. This office has been asked to coöperate with the district, if formed, and studies will be made of the effects of the drainage system as in the Modesto and Turlock districts.

Pomona. The great cost of pumping water necessitates economy in its use and furnishes an object lesson in the successful growing of crops under a high duty. A report, which is now in course of preparation, by Mr. C. F. Tait, Irrigation Engineer of this Office, will give not only details of the cost of installing and operating pumping plants, but also a general review of the duty and use of water as well as the agricultural conditions as they exist in this district.

Imperial Valley. Mr. Tait has also continued the study of conditions in this valley, and his report, printed as a Senate Document, during this year is now obtainable. The breaking through of the Colorado River into the valley and the deep cutting of the channels of the Alamo and New rivers caused thereby has furnished a natural drainage for irrigated areas. In order to determine the effect of the drainage, samples of water have been taken along New River at intervals of about five or six miles from Encina Flume to the Salton Sea during the past summer, and also from the irrigation canals in order to discover the quantity of salts carried. Monthly silt measurements on the canal systems have also been made.

The question of keeping the growth of weeds and aquatic plants out of canals and ditches and removing the silt deposits is a serious one in this State. Our mild climate and long growing period are conducive to an extraordinary vegetable growth, which not only retards velocity but increases seepage losses, and canal companies, as well as individual irrigators, are greatly concerned in its solution. The Imperial Valley has suffered more from this cause, due to the unusual climatic conditions and the large quantities of finely divided soil held in suspension by the waters of the Colorado River, than any other section of the State, and therefore methods of removing growth and silt deposits from its water courses have been experimented with to a greater extent than elsewhere. A study of the various schemes applied there, as well as in other sections of California, have been made by Mr. Tait, and the data secured will be prepared in bulletin form during this winter.

Other Work. The canal systems of the Kern County Land Company and the San Joaquin and Kings River Canal and Irrigation Company have also been investigated, and their records for a number of years copied. Under the latter system the losses due to evaporation and the effect of the growth of weeds on seepage loss have been features of the work. It is proposed to use this information as well as various other data which this office has and will collect in a publication on the San Joaquin Valley, similar to the one by Dr. Fortier on the Sacramento Valley. This valley, with more than twice the area of its northern neighbor, has less than half the water supply from natural sources, and it is therefore evident that its development beyond a certain point will depend on means whereby its natural supply may be used to the greatest advantage and a study made of the pumping possibilities to augment same.

A study of the methods of irrigation in the foothills and mountain districts, as practiced along the line of the Central Pacific Railroad between Rocklin and Colfax, is also proposed.

The adaptability of the foothill regions throughout the Sierras for a great variety of irrigated crops needs no advocacy when this rich agricultural region is considered. Its development has been retarded chiefly by its remoteness from transportation facilities. Naturally, irrigation practices must be entirely distinct from those of the valleys, the distribution of water being such as to prevent washing of the soil on the steep slopes. An investigation of the methods practiced will, therefore, be valuable in the extension of irrigation to other mountainous or hilly sections.

The publication of a bulletin on Irrigation in California is also in course of preparation, which will be a general review of existing and prospective conditions.

Pumping for irrigation, which has been a prominent feature of California agriculture and in which it is far in the lead of any of the states in the Union, is to be another feature of prospective work. With large areas still to be developed in the more arid sections of the State for which only the inadequate and intermittent flow of torrential streams is available, it is conceivable that the present area covered by pumping plants (about 300,000 acres) will be very largely increased. The need of a bulletin on this subject, which will enter only in the practical side of this question so as to be understood by those without technical training, is great.

Bulletins of the Office relating to California conditions which are at present available and may be had on application are as follows:

Farmers' Bulletin No. 116, Irrigation in Fruit Growing, by Prof. E. J. Wickson.
Farmers' Bulletin No. 138, Irrigation in Field and Garden, by Prof. E. J. Wickson.
Bulletin No. 86, Part 2, Duty of Water under Gauge Canal, Riverside, Cal.
Bulletin No. 100, Report of Irrigation Investigations in California.
Bulletin No. 104, Part 2, Duty of Water under Gauge Canal, Riverside, Cal.
Bulletin No. 108, Irrigation Practice among Fruit Growers of the Pacific Coast, by Prof. E. J. Wickson.
Bulletin No. 119, Part 2, Subterranean Water Supply of the San Bernardino Valley, by Prof. E. W. Hilgard.
Bulletin No. 133, Part 2, Irrigation Systems of Stony Creek, Cal.
Bulletin No. 145, Preparing Land for Irrigation and Methods of Applying Water.
Bulletin No. 146, Current Wheels, Their Use in Lifting Water for Irrigation.
Bulletin No. 158, Separate No. 2, Irrigation in the Santa Clara Valley, by Dr. S. Fortier.
    Mechanical Tests of Pumping Plants Used for Irrigation, by Prof. J. N. Le Conte.
    Separate No. 3, The Distribution and Use of Water in Modesto and Turlock Irrigation Districts.
    Relation of Irrigation to Yield, Size, Quality and Suitability of Fruit.
    Irrigation Conditions in the Imperial Valley.
Bulletin No. 177, Evaporation Losses in Irrigation, and Water Requirements of Crops.
Bulletin No. 181, Mechanical Tests of Pumping Plants in California.
Senate Document No. 264, Irrigation in the Imperial Valley, by C. E. Tait.
Reprint Year-Book 1907. The Use of Small Water Supplies for Irrigation. By Dr. S. Fortier.

Those which will soon be available are:

Irrigation in the Sacramento Valley, by Samuel Fortier.
The Use of Underground Water Pumped from Wells at Pomona, Cal., by C. E. Tait.
Canal Cleaning, by C. E. Tait.
Fresno Drainage Report, by V. M. Cone.
Manual of Alfalfa Irrigation, by S. Fortier.
Manual of Orchard Irrigation, by S. Fortier.
Manual of Sugar-Beet Irrigation, by F. W. Roeding.
Irrigation in California, by F. W. Roeding.
Canal Management, by Frank Adams.
Concrete Irrigation Structures, by B. A. Etcheverry.

The future of the State is bound up in its agricultural development, and it is therefore necessary that its water supply, both surface and underground, be put to the greatest and most economic use. The gradual transition of the immense grain ranches into fields of lesser area, which require more intensive cultivation and yield better returns, is now going on. Accompanying this transition is the ever increasing demand for irrigation water. Its proper use is a problem which will require continued study and a wide range of investigations, for although nearly as old as agriculture itself, irrigation depends on so many varying conditions and the solution is not at present in sight. Therefore it is meet that the State continue the work on which the prosperity of its population, both present and future, will be so largely dependent so that eventually its destiny, the greatest good to all its citizens, may be realized.

The statement of expenditures in accordance with the agreement during the period covered, is as follows:

Fiscal Year, 1906-1907.

Expenditures from State funds	$7,500 00
Expenditures from Government funds	9,158 49
Total expenditures	$16,658 49

State Funds.

Salaries			$4,297 04
Traveling expenses			1,565 52
Incidentals:			
1906.			
Aug	—A. R. Carlson, boring and casing wells, Modesto	$229 50	
Dec.	—Steiger Pottery Works, drain tile for Fresno	180 07	
	Hollenbeck & Bush, lumber, Fresno drainage	267 50	
	Donahoo, Emmons & Company, wire rope, etc., drainage	115 60	
1907.			
Jan.	—Western Building Material Company, drain tile	145 60	
	Niel White & Company, rubber boots	21 00	
Feb.	—J. Rasmussen, Woodland, lumber, labor, etc.	75 51	
Mar.	—California Hydraulic Engine & Supply Co., Century pump to Fresno	81 30	
	Donahoo, Emmons & Company, sewer pipe, Fresno	89 40	
April	—Century California Machine Works, Fresno, sundry supplies	20 20	
	Donahoo, Emmons & Company, sundry supplies	25 55	
	F. Hagemeister, farm work, Modesto, seeding	36 00	
May	—F. Hagemeister, farm work, Modesto, seeding	20 50	
	California Hydraulic Engineering Supply Co., ball bearing for pump	12 00	
	Donahoo, Emmons & Co., pipe and fittings, Fresno	22 70	
			$1,342 43
Sundries			295 01
			$7 500 00

Government Funds.

Salaries	$3,962 50
Traveling expenses	4,877 99
Incidentals	318 00
	$9,158 49

Fiscal Year, 1907-1908.

Expenditures from State funds	$7,500 00
Expenditures from Government funds	10,532 94
Total expenditures	$18,032 94

State Funds.

Salaries	$4,274 60
Traveling expenses	1,180 08

Incidentals:

1907.			
July	—B. F. White, photographic work, Berkeley	$31 71	
	G. H. Hecke, drayage of tanks, Woodland, Cal.	21 00	
	Cunningham, Curtis & Welch, San Francisco, note books, etc.	20 00	
Aug.	—Steiger Pottery Works, drain tile, San Francisco	286 40	
	Freight on tile to Fresno	73 60	
Sept.	—F. W. Hansen, Fresno, hauling tile, etc.	39 65	
Oct.	—Fresno Brick and Tile Company, tile base for drain, Fresno	37 36	
	Valley Lumber Company, Fresno, lumber, cement, etc.	174 36	
Nov.	—F. W. Hansen, Fresno, hauling material and team work	23 90	
Dec.	—F. W. Hansen, Fresno, rent of pump and engine, and pumping	176 12	
	Smith Bros., Oakland, filing cases	44 60	
1908.			
Jan.	—F. W. Hansen, Fresno, pumping	212 35	
	Oakland Furniture Company, roll-top desk	45 00	
	B. F. White, photographic work	16 25	
Feb.	—F. W. Hansen, Fresno, pumping, etc.	92 20	
	Smith Bros., Oakland, filing cases	13 50	
	Oakland Furniture Company, swivel desk chair	14 00	
Mar.	—L. Baker, Fresno, farm work, drainage tract, etc.	24 00	
April	—Winsor California Pottery and Terra Cotta Works, sewer pipe, etc., Davis Farm	108 00	
	Donahoo, Emmons & Co., dynamite, caps, fuse, fencing	67 03	
	Valley Lumber Company, Fresno, fence posts	63 46	
	F. W. Hansen, Fresno, work on tanks, etc.	21 12	
	Pacific Mill and Mine Supply Company, San Francisco, percolating tanks, Fresno	177 81	
			$1,783 42
Sundries			261 90
			$7,500 00

Government Funds.

Salaries	6,072 09
Traveling expenses	4,031 92
Sundries	428 93
	$10,532 94

FORESTRY RESOURCES.

The State, through the Board of Examiners, entered into agreement with the Forestry Service of the United States Geological Survey in 1903 for coöperative investigation of forest conditions and resources in the State, and a study of the needs of and methods for their conservation and preservation.

Appropriations made by the legislature, approved March 16, 1903, and March 18, 1905, for those purposes enabled researches to be made which resulted in the adoption of the present policy of forestry work by the State and the creation of the Board of Forestry to carry out the policy adopted. This terminated joint relations between the Board of Examiners and the Forestry Service named, and no appropriation was made by the legislature in 1907.

But by act approved March 11, 1907, the sum of $5,000 was appropriated, and the Board of Examiners empowered to enter into an agreement with the Forestry Service of the Department of Agriculture, whereby the State and the Forestry Service should jointly engage in cutting fire-trails or fire-breaks for the protection of timber on the south slope of the San Bernardino Mountains, provided that the Forest Service should expend an equal amount with the State.

Before the time for signing the agreement the duties prescribed for the Board of Examiners in the matter were transferred to the Department of Engineering, and on July 1, 1907, the Department entered into agreement with the Forest Service for the execution of the work. Fire-breaks aggregating 25.9 miles in length, of an average width of 50 feet, have been constructed under the direction of Mr. R. H. Charlton, United States Forest Supervisor.

The work has cost $8,731.61, leaving a balance of $1,268.39 of joint funds which will be expended in the construction of another trail connecting with the coöperative breaks, and in keeping the breaks clear of brush and weeds, next spring.

The report of Supervisor Charlton is as follows:

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
LOS ANGELES, November 27, 1908.

STATE ENGINEER, SACRAMENTO, CAL.

DEAR SIR: I have received your telegram of November 27th asking for report upon the work being done by the Forest Service in coöperation with the State of California. As you probably know the fire-break work was contracted last winter with the Highway Construction Company, of Redlands, Cal., and of the $10,000 available that company's work amounted to $8,731.61.

The following table will show the amount of work done on each break:

Break.	Square Rods.	Rate.	Amount Actually Due.
G	4,775.02	$0.28	$133 70
E	1,562.10	.41	640 46
E	2,050.80	.41	840 83
G	5,021.00	.28	1,405 88
B	293.80	.39	114 58
B	705.90	.39	275 30
D	1,297.90	.39	506 18
G	1,804.60	.28	505 28
C	3,188.80	.28	892 86
D	2,448 10	.39	954 75
A	808.00	.43	347 44
A	3,403.60	.43	1,463 55
C	1,669.70	.39	650 80
Totals	29,028.32	....	$8,731 61

The above work covers 25 9-10 miles of fire-break with an average width of 50 feet, and which is shown upon the maps enclosed herewith.

There remains an unexpended balance of $634.20 from the State funds and an equal balance from the Forest Service funds. I propose using the Forest Service funds for the purpose of cleaning out these fire-breaks this coming spring, as it is necessary to keep them closely hoed down for several seasons. The unexpended balance held by the State I am now using in the construction of the Daily road trail, which I have likewise shown upon the maps.

Very truly,

R. H. CHARLTON,
Forest Supervisor.

DEBRIS RESTRAINING WORKS.

The effects of the presence of millions of cubic yards of mining débris in the Sacramento River and its tributaries is a matter of common knowledge. The injury caused by this vast deposition of material, both to the lands and to the navigation of the waters of the valley, has been seen for many years. How this injury, already done, may be ameliorated and further damage prevented has been earnestly considered by able engineers.

Some one has estimated that the natural erosion by the elements reduces the Sierra Nevadas at the rate of one foot in height every 1,200 years—one inch in a century. At this rate the Sacramento River has been for ages carrying 13,000,000 cubic yards of earthy matter off the mountains every year. The agency that loosened this material from the face of the earth and started it on its travels was so gentle that its force could scarcely be measured by the most delicate instruments.

But man, learning that gold lay beneath the mountain soil, brought his ditches and flumes, his monitors—machines that could be directed by the touch of a finger and yet so powerful they would carve off the side of a mountain with utmost ease. Swarming over the hills, and into every nook and cranny, for the third of a century, he feverishly dug and washed for gold, unconscious of the devastation his scourings would cause below. Thirty thousand of his kind were said to have been counted on the tributaries of one of the streams alone. Is it any wonder, then, that in thirty years the bed of the Yuba River should have been raised 20 or 30 feet at Marysville, a hundred feet at the mouth of the canyon, and hundreds of millions of cubic yards of rock, gravel, and sand piled between? The Yuba, under natural conditions, in the same length of time, should have brought away 60,000,000 of cubic yards, but it would have been of such character that it would have been carried farther, even to the sea.

All streams, within whose watersheds hydraulic mining has been conducted, have filled more or less with débris.

The farmer who early engaged in his calling along the streams in the Sacramento Valley, soon found that the channels were too small to carry the flood waters, and after having his crops destroyed a few times by the overflowing waters, began building levees to protect them. The bed of the stream was raised and he raised his levees higher to correspond, and so it continued. Finally, the Federal Government took notice that the navigability of its streams was impaired and would surely be ruined. The courts were invoked and injunctions closed down the mines. This was a great hardship on an industry that was supporting a large population, and contributing to the National wealth.

Then Congress, by passing the Caminetti act in 1893, said to the miner: "If you will keep your débris from entering the streams and reaching the navigable waters you may work your mines."

This law created the California Débris Commission and specified its duties to be:

First—To prescribe and enforce such rules and regulations as will permit hydraulic mining to be resumed under such restrictions as will prevent injury to the navigable waters of the United States, and to the lands adjacent.

Second—To provide plans for such measures of improvement and protection for the navigable waters of the United States as appeared necessary to restore them to their former condition.

The California Débris Commission, as created by the Caminetti act, consists of three officers of the Engineer Corps, U. S. A., appointed by the President. Immediately upon being appointed the commission organized and assumed the duties prescribed.

Examinations were made of the conditions in the mining regions and in the valleys, and regulations formulated under which mining might be resumed. To prevent the débris from being carried into the streams, impounding dams were constructed behind which the detritus should be stored. The plans and specifications for these dams were prescribed by the Commission and the selection of sites for them approved before work was permitted. Under these conditions many mines which had long been idle resumed operations. These requirements are yet enforced, and the Commission is still engaged in passing upon the sufficiency of the restraining works proposed and granting permits to mine, where such works are satisfactory.

This, however, only takes care of the detritus newly produced, and does not restrain the great masses of débris which have accumulated along the water courses from being washed down by the annual flood rises, nor does it dispose of that already deposited in the large channels and which interferes with navigation.

The Commission has given much study to devising some means of holding back the loose material named from getting into the valley streams.

The Yuba River, before mining began, it is said, was a clear stream, confined between well-defined banks, lined with trees, festooned with wild grapevines. Passengers landing at Marysville from steamers had to climb up the gang-plank to go ashore. Now, if a steamer could reach there at all, the keel would be several feet higher than the streets of the city. The mass of detritus accumulated along the course of the river between its confluence with Feather River at Marysville, and the mouth of the canyon at Daguerre Point, a distance of eleven (11) miles, is estimated to contain from 350,000,000 to 600,000,000 cubic yards, and to be increasing at the rate of 3,000,000 cubic yards per year. How much more is carried each year into the Feather River and thence into the Sacramento, has never been determined.

On both sides of the river are strong levees extending from the mouth of the stream to the foothills. These levees do not confine the river to one channel, but are wide apart, as much as three miles in some places. The river changes its course with every flood stage, shifting the channel from place to place in the broad space between the levees, sometimes dividing into several channels. Thus it is continually adding to the material already built into a ridge. And this building up process would naturally continue until the stores of débris in the canyons, bars and pockets among the hills, shall be exhausted. Then would ensue the opposite process—the stream would wear down this great ridge, carrying these millions of yards of material into the rivers below.

The Commission after several years of investigation and study, selected the Yuba River upon which to begin remedial measures, it having suffered more than any other stream and presenting conditions most urgently demanding relief.

A plan of treatment was presented to Congress, which it was estimated would cost $800,000.

Congress approved the project and appropriated one half of the estimated amount with the provision that the State of California should provide the other half of the sum required. This was done and the money provided for the first comprehensive attempt at débris control. The storage system inaugurated for the mines had proven so successful that the same plan, together with other extensive systems, was adopted for the work on the river.

Now followed several years' delay while rights of way were being procured.

The project, as approved by Congress, contemplated the following features:

(1). To arrest the heavier materials and hold them from reaching the valley by a series of dams or barriers across the river, and located among the hills. Four of these were first to be constructed, and others later.

(2). To supplement the work of the barriers by a system of settling basins at the sides of the stream after it issues from the hills, the flood waters to be conducted into the basins by proper inlet works. The heavily charged waters coming to rest in the basins would drop their load of suspended matter, and then be drawn off through suitable outlets and returned to the river in a clear state.

(3). The course of the river, after entering the valley, to be controlled and directed from the foothills to its confluence with Feather River by keeping it between strong training walls, situated about 2,000 feet apart. While it is recognized that this third part of the plan will eventually cause the river to cut its channel down to a permanent hydraulic gradient, in doing which it will remove a great deal of material to the valley streams, yet that amount compared to the half billion or more yards of débris that otherwise would surely be carried down is so small it may be disregarded.

Not until 1902 had sufficient rights of way been secured to warrant the expenditure of any funds for construction, but early in that year active operations began. Contracts were let for building barrier No. 1, situated about six miles above the mouth of the canyon. This barrier was to be of brush and rock with sheet pile aprons, but it was found impossible to drive the sheet piling through the mass of rock and cobbles encountered.

This plan was abandoned and another design adopted, consisting of cribs made of brush fascines and filled with rock, and construction went on, but the first high water destroyed it. This design was similar to that used by the State of California in 1881, when barriers were constructed in the Yuba and Bear rivers, but both failed.

The plans were changed and in August, 1903, contracts were let for the construction of barriers Nos. 1 and 2. These dams were to be made of brush mattresses and cribs filled with rock all fastened with wire and cables. By November barrier No. 2, half a mile above No. 1, was completed, and barrier No. 1 constructed about one third of the distance across the stream. A storm caused a suspension of work and breached barrier No. 2 in two places. Further storms completed the wrecking of this dam, and carried away the partially completed work of dam No. 1.

During the summer of 1903, while the barriers were being constructed, work was commenced making the Daguerre Point cut. This cut was intended to be 870 feet wide at its entrance, with an average depth of 25 feet. It is cut through very hard material, the south side being in solid rock. A reinforced concrete sill extends entirely across the floor of the cut with an abutment at the north end made of the same material. This sill is expected to resist erosion which otherwise would be considerable as there may, at times, be 90,000 or 100,000 second-feet passing through. The purpose of this cut is to lead the waters of the river through a stable entrance to the channel to be formed between training walls. Work was begun upon it in 1903 and continued through the summer of 1904.

As heretofore stated, the "bed" of the Yuba River, between levees below Daguerre Point, is two to three miles wide, and filled to a depth of many feet with detritus from former hydraulic mines. At this time (1903), a gold dredging company had obtained possession of a portion of the river bed for the purpose of dredging the gravels for gold. A controversy threatened to arise as to whether they should be permitted to work in the river. An arrangement was made whereby the dredges might work provided they should pile the cobbles, obtained from working for gold, where directed by the Débris Commission, and in such way that they would form training walls and impounding levees. This work to be done without expense to the Commission.

In 1904 work was resumed on barrier No. 1 upon a new plan. It was now to be built of piles and timber framework and rock, capped by a reinforced concrete cover eighteen (18) inches thick. The ultimate height was to be thirty-six (36) feet, but the plans provided for it to be built in steps, and it was intended only to raise it a step at a time as the detritus should accumulate behind it. During this season it was completed to a height of fourteen (14) feet, being two steps of six and eight feet in height, respectively. Some levee work was done on the north side of the river below Daguerre Point.

The high water of the spring of 1905 damaged the barrier somewhat, which damage was repaired during the summer, and another step was added.

In 1906 no addition was made to the height, but some repairing was done. The abutments were raised and extended, and a spillway cut at one end.

Part of the north training wall, below Daguerre Point, was constructed, aggregating some 163,000 cubic yards of embankment.

The spring of 1907 witnessed one of the highest floods in the recorded history of the streams. Yuba River was estimated to be flowing more than 100,000 cubic feet per second on March 19th. The barrier, which had cost more than a quarter of a million dollars, was destroyed, and the large volume of detritus stored above it was liberated. The high water broke the north training wall, washing away about 1,000 lineal feet of it.

The great cost and the complete failure of the barriers to withstand the floods, was certainly a great disappointment to those who had so confidently looked forward to the solution of the problem of holding the débris in the hills.

The failure resulted in the method being abandoned, at least for the present, and attention was concentrated upon carrying toward completion the other features of the project, *i. e.*, the settling basin and training walls.

The dredges heretofore mentioned had continued working, throwing up great dikes of cobbles thirty (30) feet high and several hundred feet in width. These dikes are placed upon the lines selected by the Débris Commission so as to form parts of the great chain of works.

The south training wall, or cobble dike, begins at the inlet gates of the settling basin, at Hallets Point, on the south side of the river, and extends diagonally across the river bed, pointing upstream, to within about half a mile of the north side. It here makes a sharp angle downstream to connect with the headland at Daguerre Point. Its form is that of a large V, with the apex pointing upstream. The effect of it will be to divide the river and turn the water both ways. That running to the south side will be passed through inlet, gates, and thence into the settling basin; that passing toward the north side will be deflected through the Daguerre Point cut into the channel between training walls, and thence to the Feather River.

It should be stated that the dike has not yet been connected with the Daguerre Point head, but an opening is left there for the river until such time as the training walls shall be completed.

From the apex of the V just described, a low barrier across the north channel will cause most of the water to be diverted toward the south side into the settling basin, unless the inlet gates shall be closed, in which case the water will rise, run over the barrier, and all go down the cut.

The break in the north training wall caused by the flood of 1907, has been repaired, and about ten spur dikes constructed, extending from the levee 100 to 150 feet into the stream to ward off the current from impinging upon the embankment. Both sides and the point of all spurs, as well as the face of the levee, have been revetted with brush.

The inlet gates just named were constructed in 1906. They are built of concrete and consist of a number of rectangular openings to be closed by sliding wooden gates.

The settling basin lies south of the river and outside of the levee which is maintained to keep the river from spreading over the lands in that direction. It is about two square miles in area. The east wall of it is the natural high ground sloping up to the hills. The west wall is a levee connecting with the cobble dikes which have been thrown up along the Linda levee, and extending east and south to the high land. The Linda levee reinforced by a cobble dike, forms the north wall. The intake is at the north corner. The south levee was nearly all completed this year.

The outlet works will be located at the west corner. They are to be six large, upright cylinders, eighty (80) feet in diameter and twelve (12) feet high, connected together by conduits, and all discharging through a conduit passing under the dike and discharging into the river. The whole structure is to be of concrete. It is very probable that work will begin upon it before the end of the year.

An inspection of the map, filed in the Department of Engineering, will show that after the settling basin shall become filled with slickens, there are several square miles of the river bed between Linda levee and the south training wall, and between the north training wall and Brown's Valley levee, that can be used as settling basins, so that if the scheme of diversion and settling shall prove to be a success, the Yuba will be under control for many years before this storage capacity shall become exhausted.

Surveys have been made of the Bear and American rivers, with a view of determining some plan or system adapted to their respective needs and conditions. Neither of these streams are navigable for any portion of their length.

Settling basins may be constructed by which large amounts of débris shall be intercepted on its way to the main rivers; training walls can be built to confine the waters of the tributary streams to narrow channels and prevent them from cutting down and transporting the large masses of material accumulated in their beds; but there is still the great problem of dealing with the débris that has lodged in the channels of the navigable waters. It has been estimated that the bed of the Sacramento River, between Collinsville and the mouth of the Feather River, has risen not less than nine feet since it began receiving débris from the mines, and that there are 120,000,000 of cubic yards of such material resting in the channel between the points named.

The reduction of the waterway has progressed to such an extent that boats drawing five feet of water drag the bottom, and are frequently grounded on the shoals during low water.

The Feather River is said to have filled twenty (20) feet in depth at the mouth and fifteen (15) feet at Marysville. No records are available of its condition above Marysville, since it is not officially navigable above that point, no measurements have been made for many years.

The shoaling is so great below Marysville that no boats can go up after the low water season begins.

Mokelumne River is no longer navigable above New Hope.

Other streams are in the same condition of filled channel.

The subject of disposing of the débris in the navigable waters is so intimately connected with the one of flood control that neither can well be discussed without also considering the other.

That the height of flood water is augmented, and the damage from overflow is increased by the reduction of the sectional area of the streams caused by the deposit of silt, is accepted as a fact. Many plans have been advocated for the rectification of the channels and the prevention of damage by overflow.

The question and its early solution is a grave one and is being studied by the Débris Commission as well as by the officers of the Engineer Corps, U. S. A., who have the control and care of all navigable waters.

The Engineer Corps has just completed a survey of the Sacramento and San Joaquin rivers in its researches upon this question, and a report, it is believed, will be submitted to Congress at an early date.

The débris restraining works, on the Yuba River, herein described, are being constructed by the California Débris Commission, consisting of Lieutenant-Colonel John Biddle, U. S. A., Major C. H. McKinstry U. S. A., and Captain Thomas H. Jackson, U. S. A.

This Department desires to express appreciation of the many courtesies received at the hands of the members of the Commission.

FINANCIAL STATEMENT.

Account of Receipts and Expenditures.

ACCOUNT STATE APPROPRIATION FOR DÉBRIS RESTRAINING WORKS.

Receipts.		
1897—Appropriation by State legislature	$250,000 00	
1901—Appropriation by State legislature	150,000 00	
		$400,000 00
Expenditures.		
May 10, 1908—Expended as per vouchers approved by State Débris Commissioner		$256,742 73
May 11, 1908—Balance unexpended		$143,257 27
Dec. 1, 1908—Expended, including claims dating prior to May 11, 1908		26,790 26
Dec. 1, 1908—Balance unexpended		$116,467 01

WATER RIGHTS.

The almost daily application to this Department for information, regarding the water rights of the State and the laws governing them, has led to the following chapter which gives the law and further makes recommendations for improvement.

The Constitution of the State of California declares—

"The use of all water now appropriated, or that may be hereafter appropriated, for sale, rental or distribution, is hereby declared to be a public use, and subject to the regulation and control of the State in the manner to be prescribed by law." (Article 14, Section 1, Constitution, California.)

The law as it now stands prescribes what a person shall do to make an appropriation, as follows:

"A person desiring to appropriate water must post a notice, in writing, in a conspicuous place at the point of intended diversion, stating therein;

"1. That he claims the water there flowing to the extent of ——— (giving the number) inches, measured under a four-inch pressure;

"2. The purpose for which he claims it, and the place of intended use;

"3. The means by which he intends to divert it, and the size of the flume, ditch, pipe, or aqueduct in which it is to be diverted.

"A copy of the notice must, within ten days after it is posted, be recorded in the office of the county recorder of the county in which it is posted. After filing such notice the point of diversion, or the place of intended use may be changed, if others are not injured thereby. (See Sec. 1415, Civil Code.)

"Within sixty days after the notice is posted, the claimant must begin the work by which he intends to divert the water, and must diligently and uninterruptedly continue the work till completed, unless temporarily interrupted by snows or rain; *provided*, that, if the intended point of diversion is at or near where the Débris Commission has recommended the erection of a dam, the claimant shall begin work within sixty (60) days after the completion of the dam; *and provided further*, that, if the point of intended diversion or any part of the route of intended conveyance of the water shall be within or part of any forest reserve, national park or other public reservation, he must begin work within sixty (60) days after receiving permission from the park authorities to occupy park lands; *provided, also*, that within sixty (60) days from posting notice he must begin survey or other preliminary steps to acquire the permission sought, and in good faith make application for such permission to enter and occupy the park or reservation for the purpose claimed." (Condensed from sections 1414 and 1422, Civil Code, approved March 24, 1903.) Making surveys, and building roads or trails necessarily incident to the diversion of the water is declared to be "commencing the work."

The first need for appropriating water by the people of California, of course, was for mining purposes. Ditches were built and water diverted, at first taken only short distances, but later the water was conducted many miles to the gravels to be washed.

The miners formulated laws and customs for locating a mining claim, wherein a locator was required to give public notice of his possessory right by posting a notice on the ground, reciting that he claimed such land, roughly describing it. As a precautionary measure against its being destroyed, the notice was recorded with the recorder of the district, who was usually elected annually by a vote of the miners. The same procedure was had with water-right claims located.

When Congress enacted statutes to govern the location and sale of mineral lands, the miners' customs were made law.

When the State came into existence and the use of water had extended to irrigation, the same rule was enacted into laws governing the appropriation of water.

When the miner first began appropriating water for his use it was seldom taken far; often diverted from the stream, used, and returned again to the stream without leaving the boundaries of the "claim." A notice posted then at the point of diversion was quite sufficient to inform all who might have any interest in the matter.

The legislator who formulated the laws requiring a notice to be posted at the point of diversion could not have imagined that the water would be conveyed miles away, perhaps out of the county, across another, and distributed in the third, so far away that no one could scarcely be expected to go to the "head of the ditch" to read the notice.

In Bulletin No. 58, Office of Experiment Stations, Department of Agriculture, Mr. Elwood Mead, State Engineer of Wyoming, in discussing these notices, says: "They are of benefit to the proposed appropriator, because they give no definite right nor do they keep any one else from posting other similar notices beside them, if he so desires. They are of no service as a warning to appropriators elsewhere on the stream, because they do not and can not see them."

Taking his further remarks concerning the rivers of Wyoming and applying them to our own, we may say: To search for these notices along the banks of the Sacramento would require a journey of hundreds of miles. Who would think of traversing the banks of the San Joaquin from its mouth to its source, in many places nearly inaccessible, even on foot, looking for notices?

Perhaps the reader will say that the simplest way to find out about water rights is to go to the records. It would take him longer to learn less about the actual conditions by searching the records than by searching the banks of the stream. While the law says that the appropriator must file a copy of his notice for record, it does not require him to record proof that he had gone any further with his appropriations.

The records of every county in the State of California, with the single exception, possibly, of San Francisco, are burdened with notices of appropriations of water, taken for "irrigation, domestic and power purposes"; but nowhere will you find a record of the completion of an act of appropriation, excepting in the records of the trial courts, where litigants have fought long drawn legal battles to maintain their respective "rights."

And the decrees of the courts upon cases that have been tried do not fix the rights which the appropriator has acquired. The judgment only determines his rights as against the other party to the suit, and no other. The writer has in mind one stream in the State from which the first irrigation ditch was taken fifty years ago. In after years other ditches were built, some large, some small. Later litigations resulted, and every ditch, nearly half a hundred in number has had its lawsuits, first with one, then another, and each ditch has proven its rights against some of its neighbors, but no ditch has established its rights as against all of the others.

The aggregate amount of water awarded by all of the judgments and decrees of the courts is several times the average flow of the river, and the cases are not all tried yet. Many of the canals had suits several years ago in the course of which their rights were proven by showing how much water they had appropriated, and a decree taken for those amounts. Years afterward, in suits with other litigants, their appropriations would again be proven, and for two or three times as much as the former case, and yet, according to the testimony no enlargement of the canals had been made.

The statute prescribing the manner of acquiring a right to an appropriation says that the notice must first state the quantity of water claimed in "miner's inches, measured under a four-inch pressure." The best authority on hydraulics gives that as equivalent to 1.2 cubic feet of water per minute of time. Yet another and later act declares: "The standard miner's inch of water shall be equal to one and one half cubic feet of water per minute, measured through any aperture or orifice."

Thirty-five years ago—long before the limit of supply had been reached on any of the rivers of the State—a warning was given that unless appropriations were regulated there would trouble ensue.

The United States Board of Commissioners on the Irrigation of the San Joaquin, Tulare and Sacramento valleys of California, in a report published in 1874, said: "In seasons when there is a great surplus of waters there can be no objection to a more liberal use of it, but it seems to us indispensable that the State should lay down a general rule. There ought to be an established allotment which may vary in different districts. The cultivators who come first should not be allowed to appropriate more water than they require, because if they do, those that come after will not be able to procure a fair supply."

The warning was repeated by the then State Engineer in 1880, and a plea made for the State to define each appropriator's rights and to regulate his exercise of them. Other States, recognizing that the natural resources of the country belong to the people thereof and should be conserved and used for their benefit have done this.

The office of the Department of Engineering frequently receives communications asking for information as to the status of water rights. The inquiries show the need of some central authority to acquire such information, based upon actual facts as to the acquisition and use of the rights of appropriation.

Of all the hundreds of thousands of acres of land that have been and are being subdivided and sold in small tracts "with water rights," how many purchasers know or can ascertain from the records of the State what the "right" amounts to that he is buying with the land? It is safe to say that outside of a small area in southern California, and possibly those lands under Government reclamation, not one landowner in the State knows or can ascertain what his right is.

The states of Wyoming, Colorado, Nebraska and Nevada have, perhaps, laws governing the acquisition and exercise of water rights, more nearly conforming to modern ideas of the conservation and distribution of the waters for the benefit of the public.

In all the states named, appropriators, old and new, have their rights determined and recorded. No vested rights have been interfered with, but their rights have been ascertained, and the holders thereof are permitted to enjoy all their rights but no more.

In order that each may receive the water to which he is entitled and all be divided equitably according to the respective rights there must be some method of exercising public supervision. In seasons of scarcity if the earlier and better rights are supplied, the late comers must be denied, and without public control too often the denial is made by the stronger or more pugnacious party enforcing his claims "at the muzzle of a shotgun."

Colorado was the first to recognize the need of public supervision in the distribution of its water resources. It was followed by Wyoming and Nebraska in adopting irrigation codes.

Colorado fixes the unit of measurement of flowing water as the cubic foot per second, and the cubic foot as the unit of measurement of volume. Wyoming uses the cubic foot per second as the unit in determining the flow of a stream and in distributing the water. Nebraska finds the rights of an appropriator according to the amount of water taken and used without defining a standard. Nevada uses the cubic foot per second standard.

Nebraska fixes the allowance of water for irrigation at one cubic foot per second for seventy acres during the irrigating season. A very indefinite quantity, depending upon the length of the season. Nevada restricts the amount of water that may be appropriated for irrigation to three acre-feet per year for each acre irrigated. This is the correct way to describe the water used. In California where the climate varies so greatly in different localities, and the requirements of irrigation depend so much upon climate, soil, and crops, perhaps an equitable maximum could not be readily determined.

When Congress enacted a law in 1901 providing for the coöperation of the State and Federal governments in the construction and administration of irrigation works for the reclamation of arid lands, Nevada determined to avail herself of the benefits of such coöperation. It was found that before coöperation could be established it must be known just the extent of existing water rights, and she immediately formulated a code of water laws, based upon the experience in other states and the laws resulting therefrom.

These provisions, embody the latest attempts of a commonwealth to administer the distribution of water, which the law of Nebraska defines as "a natural want."

The laws of Nevada, brought down by amendments to February 2, 1908, are epitomized as follows :

"All natural water courses and natural lakes, and the waters thereof, which are not held in private ownership, belong to the State and are subject to regulation and control by the State.

"All existing rights, whether acquired by appropriation or otherwise shall be respected and preserved.

"There is no absolute property in the waters of a natural water course or natural lake. No right can be acquired to such except an usufructuary right, the right to use it or to dispose of its use for a beneficial purpose. When the necessity for the use of water does not exist the right to divert it ceases, and no person shall be permitted to divert or use the waters of a natural water course or lake, except at such times as the water is required for a beneficial purpose."

Section 4 of the act forbids the diversion of more water than required for economical use; forbids wasting and requires that "all surface water remaining after use, unavoidable wastage expected, shall be returned to the channel."

Section 5 fixes the maximum quantity of water that can be appropriated for irrigation at three acre-feet per year for each acre of land supplied.

Section 6 declares the cubic foot per second to be standard of measurement.

Section 7, "The prior right to the use of the unappropriated waters of the natural water courses and natural lakes as defined in this act may be acquired in the manner provided in this act, and not otherwise."

Section 8 creates the office of state engineer, fixes his salary, prescribes his qualifications and manner of appointment, and directs his office to be at the state capitol. Succeeding sections provided for the determination and recording of all rights acquired when the act went into effect, and establishes a board of irrigation to administer the irrigation laws; directs the state engineer to prepare for each stream in the State a list of the appropriations of water according to priority. Claimants are required within sixty (60) days after being notified to do so, to submit a detailed statement under oath, of their respective claims. Blank forms are furnished. Failure to submit the statement called for is a misdemeanor.

The state engineer is required as soon as practicable to examine streams and ascertain: The discharge of stream (measurements made by United States Government may be accepted, if adequate); carrying capacity of various ditches diverting water therefrom; approximate extent of lands irrigated and susceptible of irrigation from the various ditches and canals; to record results of measurements and observations, and make map showing all details. In performing such work the state engineer may avail himself of the works, records, and information of the United States Geological Surveys.

Within thirty days after preparation of such list of priorities of apropriation the state engineer to issue certificate to each person, company, or association represented on said list, setting forth: The name and post office address of appropriator, the priority-number of appropriation, the amount of water appropriated and amount of prior appropriations, and for irrigation the description by legal subdivisions of the land to which said water is to be applied.

The lists to be recorded in the records of the counties in which appropriation is made and used. Within two years after the said list is recorded, parties aggrieved, may bring suit against the state engineer and all persons having adverse interests to the parties sueing to have their respective rights determined. Such action shall be tried as speedily as possible, and the court is authorized to employ an expert upon matters in controversy. The cost of such employment to be charged against the parties to the suit.

The water commissioners shall apportion the waters according to the list of priorities as filed or as corrected by judgment of the court.'

It is the duty of the several county recorders to send the state engineer, within sixty days after the passage of the act, a complete transcript of all claims and appropriations on file in their respective offices. And the clerks of the district courts are required to send him within thirty days certified copies of all decrees affecting water rights, filed in the office of their respective district courts. The state engineer also to obtain copies of all decrees of the United States district courts affecting water rights.

The transcripts of county recorders to be furnished at the expense of the respective counties. The transcripts from the Federal courts to be paid for from state treasury.

The state engineer is made a member and the secretary of the state board of irrigation, created by a former act, which board was created to coöperate with the United States Geological Survey Investigation of Water-Supply. The duty of the board of irrigation is to divide the State into water divisions or water districts; appoint water commissioners, whose duty is defined to measure and divide among the appropriators the waters of the streams according to the priority of right, and the amount each is entitled to. Make rules and regulations for the economical administration of the waters, and fix penalties for the violation of such regulations.

The board of irrigation to fix the number and compensation of the water commissioners, who shall be under the direction of the state engineer. Their compension to be paid by their respective counties.

To interfere with the state engineer, his assistant, or with any water commissioner in the discharge of his duties is a misdemeanor, punishable by fine of five hundred dollars ($500), three months' imprisonment, or both fine and imprisonment.

The laws of Wyoming require every appropriator to maintain a headgate at the head of his ditch, so constructed that it can be locked and kept closed by the water commissioner, and when required so to do he shall construct and maintain a flume or measuring device near the head of the ditch for the purpose of assisting the water commissioner in determining the amount of water that may be diverted.

Colorado has the same requirements, and the state engineer makes a table of quantities of water that will pass at different stages.

In the latter State four years after a decree of adjudication is entered, all future contests, are barred.

Some states provided for rotation in the use of water in times of scarcity. This is sometimes a good expedient, as a given quantity of water can be much more economically used if delivered with a large 'head" than if divided up into many small parts.

Nebraska provides that "All ditches constructed for the purpose of utilizing the waste, seepage, swamp, or spring waters of the State shall be governed by the same laws relating to priority of right as those ditches constructed for the purpose of utilizing the waters of running streams," and gives to the owner of the land where the water rises the first preference.

Another phase of the appropriation problem in California, which has created an urgent need for a central authority to receive and record claims, collect data in relation thereto, and initiate and prosecute measures to determine the priority and extent of rights of appropriation, is the vast possibility of development of power from the mountain streams. Hundreds of thousands of horsepower may be produced from the waters of the streams, but great as this latent power may be, notices of appropriation have been posted claiming all or more than can be developed. The major portion of these claims are lying dormant or in many cases desultory work is being done, which, in fact, is only a pretense of complying with the requirements of the law.

In Wyoming this matter is in a measure safeguarded by authorizing the state engineer to require an applicant for a right of appropriation to submit satisfactory evidence of his good faith and ability to carry out the proposed diversion. This would prevent "dummies" from locating and holding rights for speculative purposes.

APPENDIX I.

An Act Providing for the Laying Out, Constructing, Straightening, Improvement and Repair of Main Public Highways in any County, Providing for the Voting, Issuing and Selling of County Bonds and the Acceptance of Donations to Pay for Such Work and Improvements, Providing for a Highway Commission to Have Charge of Such Work and Improvements, and Authorizing Cities and Towns to Improve the Portions of Such Highways Within Their Corporate Limits and to Issue and Sell Bonds Therefor.

The people of the State of California, represented in senate and assembly, do enact as follows:

Section 1. The board of supervisors of any county in the State, upon receiving a petition signed by freeholders, electors of the county, equal in number to at least ten per cent of the vote cast for governor in said county at the last election, praying that the matter of issuing bonds of the county for highway purposes be submitted to the electors of the county, may appoint a highway commission for such county, who shall perform the duties hereinafter specified.

Sec. 2. Said highway commission shall consist of three members, who shall be, and have been for two years, bona fide residents and freeholders of such county, and shall be especially qualified to have charge of the improvement of highways. Said commissioners shall be appointed to serve for the term of two years, and until their successors are appointed and qualified, and any vacancy in the commission shall be filled by appointment for the unexpired term; *provided*, *however*, that when the proposition for the issuance of bonds fails to carry at the election held under section seven of this act, or when all the highway improvements for which bonds are voted under said section seven are completed, or, if there is a surplus in the highway improvement fund after completion thereof, when said surplus has been expended on other highways, the existence of said highway commission shall cease. Thereafter another commission may by appointed under section one hereof. Each commissioner shall give a bond for the faithful performance of his duties, to be approved by the board of supervisors, in such amount as said board may require.

Sec. 3. For the purpose of this act a main public highway is defined to be a highway connecting different cities and towns in the same or different counties, or connecting any city or town in one county with the public highway system of another county. Provision may be made under this act for the improvement of any number of such highways jointly, to be paid for with the proceeds of one bond issue.

SEC. 4. Immediately upon their appointment said commission shall proceed with all diligence to investigate carefully the main public highways of the county and the condition thereof, and to have made a map showing said main public highways, their connections, and such other information in regard thereto as the commission may deem necessary for carrying out the purposes of this act, and to ascertain which of said main public highways should be improved by the issuance of bonds, and the kind of improvements to be made thereon, and to estimate the cost of such improvements.

SEC. 5. With the consent of the board of supervisors they may employ a competent engineer or engineers and other experts, at the cost of the county, to make any necessary surveys and prepare said map and assist the commission in determining the best material to be used and the best manner of making such improvements and the cost thereof. All surveys made for the purpose of determining the location of highways shall be approved by the county surveyor before the same is adopted by the commission.

SEC. 6. After having ascertained what improvements should be made, and the estimated cost thereof proposed to be covered by a bond issue, the commission shall make and file with the board of supervisors a report setting forth the main public highway or highways proposed to be improved, by their termini, describing generally the kind of improvements to be made thereon, and stating the estimated cost of the work to be done, and the amount to be raised by bonds therefor, and praying the said board of supervisors to call an election for the issuance of bonds of the county therefor, for the estimated amount.

SEC. 7. If said report is not approved by the board of supervisors they may refer it back to said commission for further consideration. If the board approves the report they shall adopt the same, and shall without delay call an election to determine whether bonds of the county shall be issued in the amount recommended by the commission for the purposes stated in their report. Said election shall be called and held and said bonds issued, sold and paid under and in accordance with all the provisions of law now or hereafter existing in regard to the issuance, sale and payment of county bonds, and all proceedings had in regard to such bonds shall be in accordance with such provisions of law; *provided, however*, that the board may form bond election precincts by consolidating the precincts established for general election purposes to a number not exceeding six for each bond election precinct, and shall appoint only one inspector, two judges and one clerk for each bond election precinct; *and provided, further*, that it shall be sufficient to set forth the purpose of the bond issue in said proceedings by describing the highways to be improved as the same are described in said report of the highway commission. Any defect or irregularity in the proceedings prior to the calling of such election shall not affect the validity of the bonds.

SEC. 8. Said bonds shall not be sold for less than par, and the proceeds thereof shall be paid into the treasury of the county and placed in a special fund to be denominated the "highway improvement fund;" and shall be used solely for the purposes set forth in said report of the highway commission, or such other purposes as are authorized by this act; *provided*, that if there shall be any surplus of funds voted for the improvement of any road or roads after the completion thereof such surplus may be used for the improvement of other main public highways, under the control and direction of the highway commission. The highway commission may receive and accept donations from any person for any work which they are authorized to have done, and the same shall also be paid into the said fund. No moneys shall be paid out of said fund except upon the warrant of the auditor of said county issued upon the order of the highway commission, duly allowed by the board of supervisors thereof.

SEC. 9. The doing of the work for which said bonds are issued shall be under the supervision and direction of the highway commission; *provided*, that the final acceptance thereof shall be by the board of supervisors. As soon as the funds raised by the sale of said bonds are in the treasury the commission shall proceed to prepare detailed specifications, plans, and profiles for the work to be done, or for such parts of it as they deem it advisable to have done separately, if they have not already done so, and for this purpose they may hire assistants, with the consent of the board of supervisors; and they shall then present said specifications, plans, and profiles, with their recommendations in regard to the doing of the work and letting of contracts, to the board of supervisors, who shall either adopt or reject the same as presented. If the board adopt the same they shall thereupon advertise for bids for doing the said work, or any part thereof which the highway commission recommend should be done separately, in accordance with said plans, profiles, and specifications, by publishing a notice for ten days in a daily newspaper or two weeks in a weekly newspaper, published at the county seat. Every contract for doing any part of said work shall be let, after advertisement as above provided, to the lowest responsible bidder, who will give security for the faithful performance of his contract, with sureties satisfactory to the board of supervisors in such amount as they may fix, which shall be stated in said advertisement; *provided, however*, that the board may authorize the highway commission to make contracts, without advertisement, for any part of said work the cost of which does not exceed one thousand dollars; *and provided further*, that the board may reject all bids and may thereupon readvertise for bids for doing any part or the whole of said work, or in their discretion, authorize the highway commission to purchase the necessary material, purchase or hire tools and appliances, and hire laborers, and to do the work or any part thereof without letting any contract therefor. In such case all contracts for materials, tools, or appliances, amounting to more than one thousand dollars in value, shall be let by the commission to the lowest responsible bidder, after advertisement as above provided. Said commission may, with the consent of the board of supervisors, hire all necessary engineers, inspectors, and superintendents to supervise the performance of said contract, or to have charge of the doing of said work without contract.

Sec. 10. All improvements constructed under this act shall be of a durable and lasting character, not flimsy or temporary. The macadamized or paved portion of the roadbed constructed on any highway or portion thereof improved under this act shall not exceed sixteen feet in width, unless donations are made to the highway commission for that purpose, in which case such donations may be used to defray the increased cost of constructing such macadamized or paved roadbed more than sixteen feet wide on any part of such highway specified by the donors; but no part of the proceeds of any bond issue shall be expended for such purpose. No railroad, electric road, or street railroad shall be constructed along or upon any highway, or any portion thereof, improved under the provisions of this act, except for crossings duly authorized by the board of supervisors or other legislative body having control thereof, nor shall any board of supervisors or other legislative body have power to grant any franchise for the construction of any railroad, electric road, or street railroad along or upon any such highway or portion thereof, except for crossings.

Sec. 11. Whenever the highway commission shall deem it necessary, the board of supervisors may, on their recommendation, cause any highway they propose to improve to be widened, straightened, or altered, and for that purpose they may acquire land in the name of the county by donation or purchase; and may order the condemnation of such land, and direct the district attorney to bring an action in the name of the county for that purpose under the provisions of the Code of Civil Procedure in relation to eminent domain. In such action the order of the board of supervisors shall be conclusive evidence of the regularity of all prior proceedings. The cost of purchasing or condemning such land shall be paid out of the highway improvement fund.

Sec. 12. No part of any highway lying within the corporate limits of any incorporated city or town shall be improved under the provisions of this act; but, when any highway which is being so improved shall pass through any incorporated city or town, said city or town is hereby authorized to improve the portion of such highway lying within its corporate limits, and for the purpose of raising the necessary funds therefor, to issue bonds in such manner as may be provided by law for the issuing of bonds by such city or town for public improvements.

SEC. 13. All necessary repairs to any highway improved under this act shall be made by the same officers who may be charged with the duty of repairing other highways of the county, and the cost of such repairs shall be paid out of the general fund of the county.

SEC. 14. Said highway commission shall, at least once in every six months, make and file with the board of supervisors a detailed statement of their proceedings, showing the amount of money in the highway improvement fund at the time of their last statement, the amount of all donations since received, and the purpose for which said donations were made, the amount since expended, with the purposes for which it was expended and the balance remaining, the contracts entered into or other obligations incurred by them and still outstanding, the highways in course of improvement or completed since their last statement, and the condition of the work on each, together with any other information that they may consider of interest to the public.

SEC. 15. Each member of said highway commission shall receive a per diem of five dollars for each day actually and necessarily spent in the discharge of his duties, together with his actual necessary traveling expenses, to be allowed by the board of supervisors and paid monthly. Said per diem and expenses and all other demands against the county which said highway commission are authorized to incur shall be paid out of the general fund of the county until there shall be money in the highway improvement fund derived from the sale of bonds, whereupon the general fund shall be reimbursed from the highway improvement fund for the amounts so expended, and thereafter said per diem and expenses and other demands shall be paid out of said highway improvement fund; *provided, however,* that after the preparation and filing of their report and recommendation for the issuance of bonds the members of said highway commission shall not receive any per diem or expenses unless there is money in said highway improvement fund to pay the same.

SEC. 16. This act shall take effect immediately.

APPENDIX II.

SPECIFICATIONS FOR MACADAMIZING MARIPOSA ROAD, STOCKTON, CALIFORNIA.

Location.

The work to be done under these specifications is located at Stockton, San Joaquin County, California, on what is known as the Mariposa road, beginning at the corporate limits of the city of Stockton and extending about two miles therefrom.

Character of Work.

The work herein contemplated will consist of grading the roadway and necessary drains and ditches, and laying thereon oiled macadam pavement.

Plans.

Certain drawings, including plat, profile, and cross-sections of the said Mariposa road, prepared by the county surveyor of San Joaquin County, and approved by the board of supervisors of said county, are hereby referred to and made part of these specifications. Figured dimensions and not scaled dimensions will in all cases be used.

Grading.

Grading shall include all excavating and filling of earth necessary to bring the surface of the road to the required grade and form for the reception of the pavement, the construction of the necessary ditches or drains, excavating and back filling for culverts, and removal of surplus material.

In excavating where mud, sand or other material is found which is not found susceptible of compacting under the roller, the same shall be removed to a sufficient depth, and refilled with selected earth material. All fills shall be made with good earth which will pack well when rolled, and to be free from sticks, roots, sod or other perishable matter.

Embankments must be carried up full width in layers not more than six inches thick, and well compacted by the travel of scraper teams; or, if scrapers are not used, by rolling. The slopes of the embankments to be two to one.

Subgrade.

The form of cross-section of the roadway shall be: a subgrade 16 feet wide rising four (4) inches at the crown, with a shoulder or berm at each side six inches high. Each berm five (5) feet wide, the surface being at true grade and sloping downward, away from the center, at the rate of about one (1) inch per foot. At the outer edge of each berm a drain ditch to be excavated to an established grade; the same to be two (2) feet in width on the bottom with side slopes of three to one.

The subgrade, together with the berms or shoulders, shall be thoroughly compacted in the following manner: After being trimmed to the proper form, the surface shall be rolled until smooth, and all holes shall be filled up. The entire surface shall then be plowed or cultivated to a depth of four (4) inches, thoroughly harrowed, and again rolled until firm and hard, so that no further appreciable compression can be had. The roller used shall weigh not less than 350 pounds per inch width of tire. During these operations, sufficient water shall be applied to the soil to cause it to pack in the most thorough manner. All soft or spongy places must be dug out to a depth not less than eighteen (18) inches and refilled with selected material, harrowed, and rolled as required. In sandy stretches or where the material is of such character that it will not properly pack by rolling, there must be sufficient clayey soil added to render the surface for a depth of four (4) inches, susceptible of thorough packing.

Macadam.

The subgrade, sixteen (16) feet in width between the shoulders, shall be covered with crushed rock macadam pavement, laid in three (3) layers, so that when completed the surface shall be at the established grades and of the adopted form, the completed pavement being eight (8) inches thick at the crown and six (6) inches at the sides, the surface sloping uniformly downward from the center line, falling six (6) inches in the half-width of eight (8) feet.

The first layer shall consist of good hard rock, broken so as to all pass through a 2½-inch ring, and be retained on a screen of 1¼-inch mesh.

The rock for the second layer shall be broken to all pass a 1¼-inch ring and stay on a ¼-inch screen.

The third layer or finish course shall be hard rock screenings, all passing a ½-inch mesh, all free from dust. The first course shall be, when rolled, three (3) inches thick at the center and 2½ inches at the sides, the second course 2½ inches at the center and two (2) inches at the sides, and the finish course 2½ inches at the crown and 1½ inches thick at the sides. This last course shall extend on to and be rolled into the surface of the berms their full width.

The material for each layer shall be evenly placed, either by spreading-wagons, or with shovels, and raked by hand, to an even surface, then thoroughly rolled until firm and hard before the next course shall be laid, or the work completed.

When the second layer has been lightly rolled, screenings, the same as for the finishing course, shall be spread over the surface and swept or raked into the voids until all are thoroughly filled. All surplus screenings then to be removed, and the whole rolled.

The roadway, prepared as above, shall then be sprinkled evenly over the entire surface with crude petroleum oil, in the proportions of 1¼ gallons for each square yard of surface.

The screenings for the finish course shall be spread on the oiled surface immediately after oiling, beginning at the sides and rapidly spread toward the center, raked smooth and rolled.

The rolling of each course shall be continued until the surface is compacted to the extent that no appreciable depression will be made by the wheels of a loaded wagon, and to the satisfaction of the engineer in charge.

The oil to be used hereunder shall be crude petroleum oil, of specific gravity of 12 to 14 degrees Baumé, containing not less than 66 per cent asphaltum, free from adulterations and containing not more than 2 per cent of water.

Culverts.

Wherever required, culverts shall be placed according to the plans and directions furnished by the engineer in charge.

Clearing up.

Upon completion of the work as herein specified, the contractor shall remove all surplus earth or other material from the roadway, and dispose of the same as directed by the engineer in charge. He shall remove from the roadway all tools, implements, or apparatus, and leave the road in a clean and sightly condition.

Safeguards.

The contractor shall provide barriers or signs in daytime and lights at night, plainly marking all excavations or obstructions to travel, and all portions of the work from which traffic should be excluded. He shall so conduct the work as to not obstruct travel on the highway more than absolutely necessary.

APPENDIX III.

Statement of the amounts of Taxes Levied in 1907 in the Several Counties of California for County Road Purposes, to be expended by the Boards of Supervisors during the Fiscal Year 1908-1909.

Counties.	Value of Property Taxed for Road Purposes.	Rate on Each $100 of Valuation.	Amount.
Alameda	$31,960,084	$0.40	$127,843 36
Alpine	505,430	.40	2,021 72
Amador	4,657,700	.33	15,370 41
Butte	14,554,967	.40	58 219 87
Calaveras	6,163,365	.35	21,571 78
Colusa	11,306,629	.40	45,226 52
Contra Costa	17,026,512	.40	68,106 05
Del Norte	3,543,162	.35	12,401 07
El Dorado	4,324,115	.40	17,296 46
Fresno	32,816,609	.40	131,266 44
Glenn	10,055,827	.40	40,223 31
Humboldt	19,845,082	.60	119,070 49
Imperial	3,868,455	.60	23,210 73
Inyo	3,012,670	.30	9,038 01
Kern	22,366,148	.25	55,915 37
Kings	6,326,502	.40	25,306 00
Lake	3,208,721	.50	16,043 60
Lassen	5,604,964	.40	21,419 86
Los Angeles	60,803,458	.60	364,820 75
Madera	6,626,465	.40	26,505 86
Marin	9,190,385	.37	34,004 42
Mariposa	2,178,284	.40	8,713 14
Mendocino	11,500,473	.40	46,001 89
Merced	13,036,764	.40	52,147 06
Modoc	4,905,569	.30	14,716 71
Mono	1,202,925	.20	2,405 85
Monterey	15,258,450	.40	61,033 80
Napa	8,425,485	.36	30,331 75
Nevada	4,637,485	.50	23,187 42
Orange	10,618,761	.40	42,475 04
Placer	6,568,750	.40	26,275 00
Plumas	5,307,460	.515	27,333 42
Riverside	7,669,945	.50	38,349 72
Sacramento	22,990,615	.33	75,869 03
San Benito	5,510,920	.33	18,186 04
San Bernardino	11,344 075	.60	68,064 45
San Diego	6,906,743	.60	41,438 46
San Francisco	No expenditures on county roads.		
San Joaquin	22,645,542	.40	90,582 17
San Luis Obispo	12,292,227	.40	49,168 91
San Mateo	16,455,505	.50	82,277 52
Santa Barbara	13,618,350	.40	54,473 40
Santa Clara	34,010,230	.40	136,040 92
Santa Cruz	6,978,960	.60	41,973 76
Shasta	10,996,106	.35	38,486 37
Sierra	1,651,238	.50	8,256 19
Siskiyou	13,415,688	.40	53,662 75
Solano	13,651,702	.40	54,606 81
Sonoma	22,631,235	.35	79,209 32
Stanislaus	12,088,475	.40	48,353 90
Sutter	5,788,493	.35	20,259 73
Tehama	9,595,425	.38	38,381 70
Trinity	2,830,322	.40	11,321 29
Tulare	18,027,075	.40	72,108 30
Tuolumne	6,158,838	.60	36,953 03
Ventura	8,477,429	.40	33,909 72
Yolo	14,074,535	.40	56,298 14
Yuba	3,771,105	.40	15,084 42
Totals	$664,988,434	....	$2,832,819 21

APPENDIX IV.

SONORA AND MONO ROAD.

Maintenance.

1907.			
May 31	Pay roll No. 1, labor		$680 51
July 1	Reverted to general fund, labor		5 92
31	Pay roll No. 2, labor		892 25
Aug. 31	Pay roll No. 3, labor		1,060 20
31	Pay roll No. 4, labor		527 50
Sept. 30	Pay roll No. 5, labor		825 35
30	Pay roll No. 6, labor		465 50
30	F. Sayers, board and lodging		2 00
30	J. L. Blackburn, board and lodging		5 00
Oct. 1	Ida E. Hopkins, board and lodging		4 00
	A. D. Waltze, stabling team		2 00
8	N. Ellery, expenses		9 95
31	Pay roll No. 7, labor		795 35
	Pay roll No. 8, labor		492 46
Nov. 30	Pay roll No 9, labor		300 30
	N. F. Pickle, team and driver		44 00
1908			
Apr. 30	Pay roll No. 10, labor		368 75
June 30	Pay roll No. 11, labor (bridges)		719 60
	N. Ellery, expenses		2 15
	Mundorf Mercantile Company, merchandise		26 10
	Chas. Mayer, drayage		27 10
	Conlin Bros., merchandise		19 53
July 7	N. Ellery, expenses		12 80
31	Pay roll No. 12, labor		849 15
Aug. 31	Pay roll No. 13, labor		987 88
31	Pay roll No. 14, labor		167 25
Sept. 30	Pay roll No. 15, labor		941 97
30	Pay roll No. 16, labor		289 50
Oct. 23	Western Building Material Company, cement		101 60
31	Pay roll No. 17, labor		1,006 95
	Pay roll No. 18, labor		409 40
	Total expenditures to November 1, 1908		$12,042 02
1905	Appropriation, balance	$686 43	
1907	Appropriation, maintenance fifty-ninth and sixtieth fiscal years	12,000 00	
			12,686 43
	Balance		$644 41

Bridges.

1907.		
May 31	Pay roll No. 1, labor	$550 50
June 30	Pay roll No. 2, labor	307 50
	Pay roll No. 3 labor	756 85
July 3	M. J. Curtin, use of horse	30 00
Dec. 1	J. L. Blackburn, pipe	16 00
1908.		
April 30	Pay roll No. 4, labor	287 50
May 31	Pay roll No. 5, labor	690 00
	Pay roll No. 6, labor	311 00
June 30	Pay roll No. 7, labor	230 50
	N. Ellery, expenses (maintenance)	7 20

SONORA AND MONO ROAD—*Continued.*

1908.		
July	1—A. D. Waltz, feeding and stabling team	$14 00
	J. P. Hammond, merchandise	5 00
	Mrs. C. A. Wetmore, board and lodging	3 50
	14—Western Building Material Company, cement	184 15
	23—Virginia and Truckee Railway, freight	220 40
	28—The Schaw-Batcher Company, merchandise	1 38
	31—Geo. W. Kimble, expenses	22 80
	City Livery Stable, livery	24 00
	Pay roll No. 8, labor	252 25
July	31—W. P. Fuller & Co., merchandise	7 90
Aug.	4—The Schaw-Batcher Company, merchandise	186 37
	5—Judson Manufacturing Company, merchandise	690 91
	7—Jenkins & Wells, expenses	103 15
	10—Eugene Dietzgen Company, tape	5 20
	11—Virginia and Truckee Railway, freight	255 00
	15—Pay roll No. 9, labor	452 45
	31—J. L. Blackburn, board	49 50
	Geo. W. Kimble, salary as inspector	130 00
	Batjer Teaming Company, drayage	786 20
	Pay roll No. 10, labor	442 87
	Jenkins & Wells, merchandise	15 00
Sept.	15—Pay roll No. 11, labor	426 76
Oct.	1—Batjer Teaming Company, drayage	907 12
	15—Pay roll No. 12 (maintenance)	304 05
	The Schaw-Batcher Company, cutting pipe	2 70
	20—Geo. W. Kimble, salary and expenses (maintenance)	154 35
	31—Jenkins & Wells, expense	107 73
	Western Building Material Company, cement (maintenance)	254 00
	Jenkins & Wells, 10 per cent commission on bridge work	637 70
	Pay roll No. 13, labor	298 37
	Virginia and Truckee Railway, freight	286 50
	Geo. W. Kimble, salary as inspector	80 00
	Geo. W. Kimble, expenses as inspector	40 20
	R. Terry, lumber	307 60
	J. L. Blackburn, board and lodging	44 25
	J. L. Blackburn, merchandise	72 45
	Pay roll No. 14, labor	237 57
	Total expenditures to November 1, 1908	$11,200 43
1905—	Appropriation balance, bridges	13,339 45
	Balance	$2,139 02

MONO LAKE BASIN ROAD.

Maintenance.

1907.		
June	11—H. F. Hill, labor	$38 51
	L. W. Dechambeau, merchandise	1 50
Aug.	31—Pay roll No. 1, labor	404 72
	Robert Murray, repair work	14 20
	Joseph Schreck, livery	20 00
	J. B. Anderson, merchandise	4 20
	J. P. Hammond, merchandise	104 88
	Chris Mattly & Bros., merchandise	44 10
Sept.	16—Wm. Vogt, meats	47 12
	28—Thos. Silvester, merchandise	30 50
	30—John Mattly, livery	20 50

MONO LAKE BASIN ROAD—*Continued.*

1907.			
Sept. 30—	Robert Murray, singletree		$2 00
	E. A. Benedict, notary fees		2 50
	Pay roll No. 2, labor		231 62
Oct. 8—	N. Ellery, expenses		37 00
Nov. 8—	H. F. Hill, salary and expenses		156 27
	J. Swanton, board and lodging		3 25
	F. W. Lane, board and lodging		4 00
	E. L. Brandon, board and lodging		1 50
1908.			
July 31—	H. Vogt, merchandise		17 32
	H. Buggs, livery		15 00
	J. S. Cain, merchandise		21 50
	Adams & Cain, livery		25 00
	T. Silvester, merchandise		20 00
	F. H. Depew, expenses		26 00
	J. B. Anderson, merchandise		2 00
	J. P. Hammond, merchandise		122 03
	Pay roll No. 2, labor		301 47
Aug. 31—	F. H. Depew, expenses		4 75
	W. Vogt, meats		30 00
	T. Silvester, livery		25 00
	J. B. Anderson, livery		12 00
	C. C. Haddan, horseshoeing		3 00
	J. P. Hammond, merchandise		107 24
	Pay roll No. 3, labor		377 37
	Total expenditures to November 1, 1908		$2,278 05
1907—	Appropriation balance, maintenance	$40 74	
	Appropriation fifty-ninth and sixtieth fiscal years	2,500 00	
			2,540 74
	Balance		$262 69

LAKE TAHOE WAGON ROAD.

Maintenance.

1907.		
July 31—	A. S. Lyon, superintendent, salary	$50 00
	Pay roll No. 1, labor	1,053 15
Aug. 31—	A. S. Lyon, superintendent, salary	50 00
	Pay roll No. 2, labor	764 60
Sept. 30—	Pay roll No. 3, labor	1,088 32
	A. S. Lyon, superintendent, salary	50 00
	Pay roll No. 4, labor	249 00
Oct. 31—	A. S. Lyon, superintendent, salary	50 00
	Pay roll No. 5, labor	890 77
Nov. 30—	A. S. Lyon, superintendent, salary	50 00
Dec. 31—	Pay roll No. 6, labor	252 05
	A. S. Lyon, superintendent, salary	50 00
1908.		
Jan. 30—	A. S. Lyon, superintendent, salary	50 00
Feb. 29—	A. S. Lyon, superintendent, salary	50 00
Mar. 31—	A. S. Lyon, superintendent, salary	50 00
April 30—	A. S. Lyon, superintendent, salary	50 00
May 31—	A. S. Lyon, superintendent, salary	50 00
June 30—	A. S. Lyon, superintendent, salary	50 00
	Geo. Marquart, labor	84 00
	A. B. Kyburz, board and lodging	7 00

LAKE TAHOE WAGON ROAD—*Continued.*

1908.		
June 30—	John Titler, board and lodging	$9 00
July 12—	Capital Carriage and Auto Company, auto hire	75 00
	N. Ellery, expenses	2 50
July 25—	Capital Sewer Pipe Works, sewer pipe	205 00
July 31—	Pay roll No. 7, labor	872 24
	A. S. Lyon, superintendent, salary	50 00
Aug. 31—	Pay roll No. 8, labor	964 75
	A. S. Lyon, superintendent, salary	50 00
Sept. 30—	A. S. Lyon, superintendent, salary	50 00
	Pay roll No. 9, labor	1,209 95
Oct. 31—	Pay roll No. 10, labor	700 30
	A. S. Lyon, superintendent, salary	50 00
	Total expenditures to November 1, 1908	$9,227 63
1907—	Appropriation, fifty-ninth and sixtieth fiscal years	10,000 00
	Balance	$772 37

Survey.

1907.			
May 31—	Pay roll No. 1, labor		$834 20
June 11—	A. S. Lyon, superintendent, salary (May 18 to May 31)		22 55
28—	N. Ellery, expenses		53 00
	A. S. Lyon, superintendent, salary		50 00
30—	Pay roll No. 2, labor		635 60
July 23—	McKee, Carr & Company, merchandise		8 85
24—	The Thomson-Diggs Company, merchandise		2 80
	H. S. Crocker Company, merchandise		1 50
25—	Robert Bench, board and lodging		5 00
	Marks & Woodward, drayage		12 00
Aug. 1—	F. A. Gerbade, concrete blocks		44 50
5—	Mrs. N. Titler, board and lodging		51 50
7—	A S. Lyon, hauling		38 00
9—	A. B. Kyburz, board and lodging		63 60
31—	Wm. Martin, board and lodging		85 74
	Mrs. N. Titler, lodging		4 50
	C. G. Celio & Sons, board and lodging		97 98
	A. B. Kyburz, board		1 50
Sept. 2—	J. A. Raffeto, board		3 00
3—	G. W. Kimble, C.E., salary and expenses		226 40
	Roy M. Fryer, labor		129 99
	H. Phleger, labor and expenses		90 75
	F. M. Jordan, labor and expenses		82 00
	M. J. Dillman, labor and expenses		82 00
	F. H. Short, labor		78 75
	Frank Phelps, labor		189 00
20—	C. G. Celio & Sons, drayage		180 00
26—	Marks & Woodward, team and driver		28 00
Oct. 5—	N. Ellery, expenses		15 50
1908.			
May 1—	Pay roll No. 3, labor		405 55
June 30—	Pay roll No. 4, labor		70 16
	Total expenditures to November 1, 1908		$3,593 92
1907—	Appropriation balance (survey)	$1,595 35	
	Appropriation	3,000 00	
			4,595 35
	Balance		$1,001 43

LAKE TAHOE WAGON ROAD—*Continued.*

1907. *Bridges.*

June 30—	Pay roll No. 1, labor	$363 20
	A. B. Kyburz, board	7 25
July 31—	Joseph Rupley, stage fare	7 50
Sept. 30—	Mrs. A. S. Lyon, fruit and vegetables	10 85
	T. D. Montgomery, labor	97 62
	Mrs. A. B. Randall, cook	60 00
	A. S. Lyon, horse hire	151 50
Oct. 1—	J. S. Creighton, wagon rent and coal	11 45
	N. Fossati, merchandise	140 89
	Total expenditures	$850 26
1905.—	Appropriation, balance	850 35
	Balance	$0 09

ALTURAS AND CEDARVILLE ROAD.

1908.

July 17—	N. Ellery, expenses	$56 95
Sept. 30—	Pay roll No. 1, labor	89 13
	E. Lauer & Sons, merchandise	7 50
	The Modoc Coöperative Association, merchandise	25
	Frank Kaufman, team hire	5 62
	D. Methvin, team hire	4 50
	P. S. Methvin, team hire	6 00
	C. Godfrey, team hire	4 50
	J. H. Godfrey, team hire	4 50
	H. Putman, team hire	4 50
	L. Estes, team hire	3 00
	J. Denson, team hire	75
Oct. 15—	Pay roll No. 2, labor	472 00
	E. C. Huestis, expenses	2 00
	Ben Tom, gravel	29 28
	E. Lauer & Sons, merchandise	3 00
	Alturas Hotel, board	23 75
	The Modoc Coöperative Association, merchandise	29 70
	T. H. Johnstone Company, merchandise	26 70
	J. H. Godfrey, team hire	17 25
	Frank Kaufman, team hire	12 75
	D. Methvin, team hire	12 75
	P. S. Methvin, team hire	12 75
	C. Godfrey, team hire	14 25
	H. Putman, team hire	15 75
	J. Dinson, team hire	12 00
	M. Chester, team hire	15 75
	T. Carter, team hire	10 50
	G. Griner, team hire	18 00
	L. Estes, team hire	11 25
	L. Porter, team hire	9 00
Oct. 31—	Pay roll No. 3, labor	322 25
	The Modoc Coöperative Association, merchandise	2 31
	The Ash Creek Lumber Company, lumber	36 37
	J. H. Godfrey, team hire	18 00
	C. Godfrey, team hire	16 50
	M. Chester, team hire	18 00
	G. Griner, team hire	18 75
	L. Porter, team hire	28 50
	T. Porter, team hire	15 00

ALTURAS AND CEDARVILLE ROAD—*Continued.*

1908.		
Oct. 31—J. Porter, team hire		$0 75
G. Reynolds, team hire		15 75
Nov. 15—Pay roll No. 4, labor		264 87
The Modoc Coöperative Association, merchandise		1 75
E. Huddleson, board		2 75
Alturas Hotel, board		18 25
E. C. Huestis, expenses		50
C. H. Godfrey, team hire		14 25
J. H. Godfrey, team hire		18 00
T. Porter, team hire		18 00
G. Griner, team hire		16 50
M. Chester, team hire		16 50
T. Porter, team hire		28 50
20—Pay roll No. 5, labor		86 25
N. A. Cornish, notary fees		2 50
Powers & Bush, labor		1 50
Alturas Hotel, board		5 50
Ben Tom, gravel		2 92
E. C. Huestis, expenses		23 20
E. J. Green, team hire		6 00
J. Baurman, team hire		2 25
G. Griner, team hire		12 00
C Godfrey, team hire		6 00
J. H. Godfrey, team hire		7 50
23—Powers & Bush, labor		14 50
E. C. Huestis, timekeeper, salary and expenses		201 85
Total expenses to November 1, 1908		$2,199 65
1905—Appropriation, balance	$72 33	
1907—Appropriation	7,000 00	
		7,072 33
Balance		$4,872 68

TRINITY, TEHAMA, AND SHASTA ROAD.

1907.	
April 1—H. S. Smith, drafting	$150 00
17—Geo. H. Thompson, merchandise	137 40
21—Northwestern Pacific Railroad, freight	3 50
H. S. Smith, drafting	150 00
Carlotta Store, merchandise	4 75
28—G. G. Kesling, lodging	15 75
30—James Lynch, labor	15 00
Chas. Robb, labor	16 00
E. Park, labor	16 00
J. A. Meyers, labor	16 00
Hans Erickson, labor	20 25
Wm. McDonald, labor	18 00
Chas. Pine, labor	20 00
Sept. 1—J. N. Lentell, civil engineer, salary and expenses	98 83
Sept. 16—Sun Tent and Awning Company, tents	54 75
Oct. 1—Healy Bros., merchandise	37 23
G. G. Kesling, lodging	4 50
Louis Espie, merchandise	16 75
California Iron Works, repairs	2 25
Hotel Carlotta, lodging	36 50
H. S. Smith, drafting	150 00

TRINITY, TEHAMA, AND SHASTA ROAD—*Continued.*

1907.		
Oct. 1—	Jas. J. Smith, merchandise	$7 55
	R. W. Cuff, merchandise	34 55
	Wm. Prattie, merchandise	55 15
Oct. 31—	R. L. Boehne, labor	200 00
	Chas. Pine, labor	143 50
	Wm. McDonald, labor	126 00
	Hans Erickson, labor	129 25
	J. A. Meyers, labor	106 00
	E. Park, labor	106 00
	J. N. Lentell, civil engineer salary and expenses	580 30
	F. Vladyka, livery	13 00
	H. W. Bowen, livery	15 00
	Valley Produce Company, merchandise	166 53
	J. M. McNight & Co., merchandise	35 80
	H. H. Lyon, board and lodging	6 00
	N. Ellery, expenses	39 85
	H. H. Buhne Company, cable	43 75
Nov. 1—	Gillette Tea and Coffee Company, merchandise	19 10
	Duck Brothers, tent	13 75
	H. S. Smith, drafting	150 00
	J. N. Lentell, merchandise	12 00
	Fitzgerald, merchandise	8 70
	R. L. Boehne, board and lodging	23 10
9—	H. L. Knowles, merchandise	30 80
	Louis Espie, merchandise	2 80
	T. C. Patterson, merchandise	6 57
	James Mullane, meats	25 92
18—	N. Ellery, expenses	75
	J. N. Lentell, civil engineer, salary	204 00
30—	Pay roll No. 1, labor	494 15
Dec. 1—	H. Schlomer, merchandise	5 35
	Geo. H. Thompson, merchandise	4 45
	Goos & Behring, merchandise	12 45
	C. E. Pine, expenses	3 60
	C. O. Lincoln & Co., merchandise	15 70
	J. N. Lentell, expenses	243 45
31—	Pay roll No. 2, labor	359 90
	H. S. Smith, drafting	150 00
1908.		
Jan. 1—	F. M. Helmke, stage charges	2 70
2—	J. D. Cobb, board and lodging	70 80
	J. N. Lentell, expenses	6 85
	E. A. Woldorff, merchandise	107 16
	G. W. Tinsley, merchandise	136 69
Feb. 1—	J. N. Lentell, expenses	4 49
	H. S. Smith, drafting	150 00
Mar. 1—	H. S. Smith, drafting	150 00
9—	W. F. Purnell, merchandise	64 00
July 28—	A. L. Machinery Company, one half cost of steam shovel	2,625 00
	W. F. Purnell, merchandise	8 00
Sept. 10—	H. S. Smith, drafting	150 00
11—	Archie McBride, board and livery	138 50
	N. Ellery, expenses	74 20
	Ben Emerson, labor	35 00
	Gillette Tea and Coffee Company, merchandise	9 00
	Vitzhum Bros., livery	32 00

TRINITY, TEHAMA, AND SHASTA ROAD—*Continued.*

1908.		
Sept. 11	Geo. H. Thompson, merchandise	$21 30
	Cosgrove & Co., livery	12 00
	G. W. Huestis, stabling outfit	8 00
	Southern Pacific Company, freight	615 43
Oct. 14	H. S. Smith, drafting	150 00
31	H. S. Smith, drafting	150 00
	Total expenditures to November 1, 1908	$9,299 35
1907-08	Appropriation (survey and construction)	50,000 00
	Balance	$40,700 65

DOWNIEVILLE-SIERRA ROAD.

907.		
July 8	Paul Oakley, merchandise	$2 10
9	John Costa Company, merchandise	8 25
	National Exchange Hotel, board	4 00
	J. B. Gurnel, stage fares	26 00
11	A. A. Meyer, livery	2 00
	R. L. Taylor, brush hooks	2 50
29	Lavezzola Bros., drayage	3 00
	C. J. York, shop work	2 00
	Benj. Pauly, survey stakes	1 00
	A. A. Meyer, livery	4 00
	N. Ellery, expenses	16 95
	C. S. Scott, expenses	11 90
30	C. J. York, board and lodging	10 00
	John Costa, board and lodging	9 33
	St. Charles Hotel, board and lodging	94 00
Aug. 1	J. B. Gray, expenses	18 55
	Pay roll No. 1, labor	335 00
5	John Costa Company, merchandise	85 56
23	W. H. Ellmore, labor	10 00
26	Victor Dondero, labor	2 50
	Mrs. L. Dondero, board	1 00
28	Chas. Rosasco, board	82 00
29	Chas. Rosasco, moving camp	3 00
31	A. A. Meyer, livery	6 00
	A. G. Hunter, board and lodging	4 00
Sept. 1	J. T. Lavezzola & Co., board and lodging	45 00
	Pay roll No. 2	482 50
2	C. J. York, repair work	75
9	Capital Machine and Auto Company, auto hire	75 00
	C. S. Scott, expenses	11 90
21	Chas. Rosasco, board	18 00
27	Sun Tent and Awning Company, tents	43 80
30	Downieville Stage Company, stage fare	8 00
	Ross L. Taylor, merchandise	1 40
	Chas. Rosasco, board	15 00
	J. T. Lavezzola & Co., board and lodging	49 50
	John Costa Company, merchandise	12 70
Oct. 1	John Costa Company, merchandise	179 39
	J. B. Gray, expenses	50
	Pay roll No. 3, labor	312 50
17	Meyer, Costa & Co., meats	10 40
19	J. T. Lavezzola & Co., board and lodging	3 00
	Ernest T. Marvin, board and lodging	52 00
	Geo. W. Kimble, expenses	31 65

DOWNIEVILLE-SIERRA ROAD—*Continued.*

1907.		
Oct. 19—	John Costa Company, board	$6 70
Nov. 1—	J. B. Gray, expenses	14 65
	Chas. Johnston, expenses	17 10
	R. Hawtrey, expenses	19 20
	Pay roll No. 4, labor	464 00
	J. B. Gray, salary (October)	150 00
	J. B. Gray, salary (November)	150 00
Dec. 31—	J. B. Gray, salary (December)	150 00
1908.		
Jan. 15—	J. B. Gray, salary (7 days)	35 00
July 31—	H. E. Quigley, recording	3 40
	N. Ellery, expenses	18 00
	J. T. Lavezzola & Co., board and lodging	9 00
	E. S. Parke, livery	20 00
	A. A. Meyer, livery	53 88
	Benj. Hartling, blacksmithing	9 50
	C. J. York, merchandise	5 50
	St. Charles Hotel, merchandise	8 70
	Louis C. Fortier, merchandise	4 50
	Turner Hadley Company, merchandise	613 99
	John Costa Company, merchandise	462 97
	Pay roll No. 5, labor	386 70
Aug. 31—	E. J. Rubottom, plow	29 65
	Meyer, Costa & Co., meats	156 05
	Latreille Bros., merchandise	6 45
	Andrew Bachels, merchandise	110 29
	John Rosasco, merchandise	5 40
	Benj. Hartling, blacksmithing	1 50
	J. A. May, merchandise	7 34
	John Poñto, merchandise	16 09
	John Costa Company, merchandise	1,029 06
	Pay roll No. 6, labor	1,660 25
Sept. 30—	L. C. Fortier, merchandise	2 50
	Owens Bros., merchandise	24 10
	John Costa Company, merchandise	692 07
	Pay roll No. 7, labor	1,209 00
Oct. 15—	Henry E. Quigley, recording	1 00
	Benj. Hartling, merchandise	7 00
	Latreille Bros., merchandise	4 75
	L. D. Davis, labor	10 00
	Meyer, Costa & Co., merchandise	107 17
	Chas. Rosasco & Co., merchandise	0 34
	E. L. Case, merchandise	15 00
	Wm. Shaughnessy, lumber and freight	24 95
	M. P. Ormsby, salary and expenses	481 10
	J. E. Mitchell, salary and expenses	340 15
	Pay roll No. 8, labor	394 60
	John Costa, merchandise	77 10
	Total expenditure to November 1, 1908	$11,123 33
1907-08—	Appropriation (survey and construction)	12,000 00
	Balance	$876 67

KINGS RIVER CANYON HIGHWAY.

1907.		
Aug.	12—E. J. Rubottom, road plow	$41 15
	14—Donahoo, Emmons & Co., merchandise	273 21
	C. J. Sykes, expenses	8 05
	22—Matt Simonish, auto hire	8 00
	31—Fresno Agricultural Works, road grader	32 00
	Hollands, merchandise	33 45
	N. Ellery, expenses	26 90
	R. O. Kimbrough, merchandise	55
	The Thomson-Diggs Company, merchandise	1 00
	H. S. Smith, drafting	150 00
	G. M. Wilson, labor	58 50
	Mitchell & McHaley, meats	30 69
	Agie & Pool, camp outfit	239 05
	Pay roll No. 1, labor	614 35
	Mrs. Dan Harrigan, board and lodging	20 55
	Donahoo, Emmons & Co., merchandise	134 79
	Kutner & Co, merchandise	119 56
Sept.	1—E. Works, vegetables	9 95
	2—Kutner & Co., merchandise	94 23
	3—Donahoo, Emmons & Co., merchandise	40 00
	Bill Bailey, labor	6 25
	W. and Mrs. Storms, labor	12 35
	4—H. Miller, labor	7 50
	H. Fay, labor	7 50
	Agie & Pool, horse hire	12 00
	5—T. B. Parker, labor	6 25
	12—S. Whitton, labor	18 75
	L. Reese, labor	17 00
	14—Geo. Burgan, labor	13 00
	Joe Neimi, labor	23 00
	Kutner & Co., merchandise	8 63
	15—Kings River Stage and Transportation Company, stage charges	65 56
	24—W. W. Wooldridge, expenses	10 95
	30—Pay roll No. 2, labor	1,245 65
	Hollands', merchandise	121 85
	Donahoo, Emmons & Co., merchandise	333 18
	Kutner & Co., merchandise	116 42
	Anderson & Iverson, merchandise	12 95
	J. E. Mitchell, board and lodging	36 60
Oct.	1—Donahoo, Emmons & Co., merchandise	6 00
	Mitchell & McHaley, meats	70 11
	J. E. Mitchell, merchandise	88 35
	31—Pay roll No. 3, labor	961 82
	Mrs. Dan Harrigan, board and lodging	25 75
	P. A. Kanawyer, board and horses	101 35
	Jas. Clay, labor	69 75
	Gale Hammat, labor	85 50
	C. J. Sykes, salary and expenses	109 65
	E. J. Rubottom, plow point	6 00
	Holland & Holland, merchandise	66 80
	Donahoo, Emmons & Co., merchandise	121 66
	Kutner & Co., merchandise	93 60
	C. B. Drake, merchandise	180 55
	Hume-Bennett Lumber Company, lumber	30 51
	County Recorder, recording fees	17 40
Nov.	10—Pay roll No. 4, labor	202 40

KINGS RIVER CANYON HIGHWAY—*Continued.*

1907.		
Dec. 11—	H. Gallagher, vegetables	$9 95
	J. J. Street, board	3 50
	Dan Harrigan, board and lodging	33 95
	Clark Bros., blacksmithing	7 00
	J. E. Mitchell, merchandise	2 75
	W. D. Mitchell, meats	86 85
	M. P. Ormsby, expenses	60 80
	Agie & Poole, horse hire	4 00
	M. P. Ormsby, salary	509 13
	J. E. Mitchell, salary	300 00
	Donahoo, Emmons & Co., merchandise	380 40
	Kutner & Co., merchandise	199 78
	Kings River Stage and Transportation Company, stage charges	152 07
	Hume-Bennett Lumber Company, merchandise	370 76
1908.		
Jan. 15—	E. B. Henderson, salary	450 00
	P. A. Kanawyer, merchandise	81 30
	Joe Reilly, labor	2 00
	J. W. Dodge, labor	12 00
	Carl Anderson, labor	19 12
	Jas. W. Carter, labor	21 66
	Wm. Allen, labor	13 50
	Claude Winsby, labor	100 68
	W. W. Wooldridge, labor	212 50
	Gale Hammat, labor	158 12
	Jas. Clay, labor	182 25
	Sam Barrow, labor	118 68
	Charley Barnum, labor	115 62
	E. B. Henderson, expenses	24 35
Jan. 15—	W. D. Mitchell, meats	9 54
	Dan Harrigan, board and lodging	12 95
	Anderson & Iverson, board and lodging	83 00
	Walker & Brattin, meats	24 42
May 9—	Sam Gebbs, labor	4 00
	John Lisle, labor	8 05
	P. A. Kanawyer, pack stock	495 85
	Kings River Stage and Transportation Company, stage fares	200 00
22—	N. Ellery, expenses	47 00
July 10—	Waterbury Company, merchandise	159 78
	Donahoo, Emmons & Co., merchandise	431 37
	Valley Grain and Warehouse Company, merchandise	68 75
	Millwood Store, merchandise	1 95
	Kings River Stage and Transportation Company, livery	19 50
	I. L. Street, hay	50 68
	Mitchell & McHaley, meats	146 40
	Coblentz Bros. Company, merchandise	125 47
	Pay roll No. 5, labor	194 20
	Pay roll No. 6, labor	1,326 65
11—	Southern Pacific Company, freight	4 93
	Cross Hardware Company, merchandise	10 53
	A. L. Young Machinery Company, merchandise	63 00
	A. L. Young Machinery Company, ½ cost steam shovel	2,625 00
12—	Palace Hotel (Visalia), board and lodging	6 50
17—	Harron, Rickard & McCone, merchandise	540 42
18—	W. F. Cason, drayage	142 50
	N. Ellery, expenses	26 70
	W. R. Spalding Lumber Company, lumber	29 52

KINGS RIVER CANYON HIGHWAY—*Continued.*

1908.		
July 23—	W. J. O'Neill & Co., truck	$145 00
31—	Pay roll No. 7, labor	1,804 90
Aug. 1—	Mitchell & McHaley, meats	113 04
	Cross Hardware Company, merchandise	12 55
	O. M. Burk, hay	60 54
	Ed Walker, board	7 85
31—	Coblentz Bros. Company, merchandise	21 79
	Hume-Bennett Lumber Company, merchandise	505 49
	Donohoo, Emmons & Co., merchandise	601 62
	Pay roll No. 8, labor	1,306 42
Sept. 22—	W. T. Runyon, hay	1 50
	W. J. Eldridge, labor	2 50
	T. A. Hammond, board	41 75
	Mrs. Dan Harrigan, board	7 20
	Mitchell & McHaley, meats	85 44
	Kings River Stage and Transportation Co., horse hire and drayage	510 18
	O. M. Burk, hay	56 76
	Coblentz Bros..Company, merchandise	20 25
	Donahoo, Emmons & Co., merchandise	297 91
Oct. 1—	N. Ellery, expenses	6 30
	K. Cooksey, merchandise	32 95
	T. Deems, drayage	338 00
	W. F. Stafford, hay	12 00
	Kings River Stage and Transportation Company, fare and freight	5 50
	John Arney, drayage	223 47
	R. F. Smith, merchandise	21 80
	C. S. Hedrick, drayage	332 90
	Wing Bros. Company, hay	18 00
	W. H. Canan, hay	18 00
	W. Koehn, labor and merchandise	94 50
	Hume-Bennett Lumber Company, merchandise	300 48
Oct. 1—	E. B. Henderson, expenses	35 95
	Gaines & Smith, merchandise	70 50
	Pay roll No. 9, labor	1,043 20
	Pay roll No. 10, labor	869 50
	O. M. Burk, hay	68 76
	Coblentz Bros. Company, merchandise	18 75
	W. J. O'Neil & Company, (collected in error) (Offset by payment to Kings River Stage and Transportation Company, November, $145.00.)	145 00
	Burnett Bros., merchandise	18 75
	T. J. Clarkson, merchandise	25 00
	Mitchell & McHaley, meats	76 24
	Donohoo, Emmons & Company, merchandise	113 78
	Hume-Bennett Lumber Company, merchandise	350 41
31—	H. F. Hill, salary and expenses	882 85
	J. T. Harriman, labor	221 20
	Southern Pacific Company, freight	615 43
	Total expenditures to November 1, 1908—State and county	$28,301 66
	One third paid by Fresno County	9,433 85
	Two thirds paid by State	$18,867 81
1905—	Appropriation balance—State	22,486 66
	State balance	$3,618 85
	Fresno County balance	1,206 28
	Total balance, State and Fresno County, November 1, 1908	$4.825 13

RECTIFYING RIVER CHANNELS.

Auditing Board Appropriation.

1907.		
April 30	Geo. W. Peltier, advances, account of river trip	$15 00
July 9	J. B. Gray, engineer, salary	20 00
	J. J. McCarthy, chainman, salary	8 75
	Chas. Johnston, chainman, salary	8 75
	W. W. Wooldridge, rodman, salary	6 25
29	N. Ellery, expenses	5 40
31	Hotel Riverside, board and lodging	4 50
Aug. 2	N. Ellery, expenses	5 30
	P. M. Norboe, expenses	27 95
5	J. J. McCarthy, salary and expenses	13 40
Sept. 4	C. J. Rhodin, draftsman, salary	54 00
	J. J. McCarthy, salary	25 00
	The Schaw-Batcher Company, merchandise	2 10
	Veach & Snow, merchandise	2 65
	H. S. Crocker & Co., merchandise	14 99
	The A. Leitz Company, merchandise	13 60
	Palace Restaurant, meals	6 00
27	Edward Goodwin, expenses	2 50
28	Hotel River View, board	10 50
	M. Kuhn, boat hire	12 50
30	Crescent Blue Printing Company, blue prints	5 18
Oct. 1	J. J. McCarthy, salary	52 50
	C. J. Rhodin, salary	9 00
5	N. Ellery, expenses	2 70
8	P. M. Norboe, expenses	46 95
	R. O. Kimbrough, merchandise	1 60
	N. Ellery, expenses	2 10
16	Edward Goodwin, expenses	6 45
17	Geo. W. Tibbetts, auto hire	20 00
23	J. M. Pike, board and lodging	19 05
24	J. M. Campbell & Sons, livery	16 00
25	Sun Tent and Awning Company, merchandise	5 00
31	J. J. McCarthy, salary	27 50
	P. M. Norboe, expenses	32 25
	Silva & Co., launch hire	30 00
	The Sacramento Union, advertising	15 00
Nov. 16	Western Building Material Company, cement	139 70
Dec. 1	M. J. Boggs, expenses	69 80
13	Geo. W. Tatterson, expenses	7 00
	Edward Goodwin, expenses	3 00
15	Pay roll No. 1, Rocky Point	89 10
	Ralph Varuna, boat hire	12 00
	Reclamation District No. 537, dredging	974 55
21	E. B. & A. L. Stone Company, crushed rock	173 07
23	The Schaw-Batcher Company, merchandise	612 40
	Western Building Material Company, freight paid on cement	27 63
	Pay roll No. 2, Rocky Point	328 88
	J. J. McCarthy, salary	35 00
	P. M. Norboe, expenses	20 55
30	Geo. W. Tatterson, expenses	3 50
	Reclamation District No. 537, dredging	1,210 90
31	Bay Development Company, gravel	349 20
	Waterbury Company, wire rope	1,764 38
	The Sacramento Union, advertising	10 80
	Edward Goodwin, expenses	3 70
	Pay roll No. 3, Brannan Island	58 39
	Fashion Stables, livery	2 50

RECTIFYING RIVER CHANNELS—*Continued.*

1908.		
Jan. 3—	Pay roll No. 4, Rocky Point	$170 60
	Pay roll No. 5, Rocky Point	76 50
4—	Pay roll No. 6, Brannan Island	95 50
6—	Reclamation District No. 537, dredging	885 46
	Reclamation District No. 537, dredging	929 09
22—	The Sacramento Union, advertising	10 80
	J. J. McCarthy, salary	67 50
	F. C. Miller, inspector, salary	130 00
	Hugo Frommelt, inspector, salary	245 00
	Western Building Material Company, cement	602 00
	Waterbury Company, wire rope	383 77
	Western Hotel, Marysville, board and lodging	31 40
	A. C. Reed, salary	100 00
	Pay roll No. 7, Brannan Island	181 50
	The Schaw-Batcher Company, merchandise	49 17
	Pay roll No. 8, Brannan Island	57 91
	C. H. Penny, boat hire	5 00
	N. Ellery, expenses	15 45
	J. J. McCarthy, salary	67 50
	P. M. Norboe, expenses	13 80
30—	Pay roll No. 9, Brannan Island	161 25
	Bay Development Company, gravel	183 00
	Southern Pacific Company, freight	25
	Hugo Frommelt, expenses	25
	Waterbury Company, wire rope	56 00
31—	N. Ellery, expenses	7 50
	Pay roll No. 10, Brannan Island	35 50
	Waterbury Company, wire rope	1,120 78
	White, Cooley & Cutts, merchandise	58 60
Feb. 1—	Swift Bros., repairs	2 70
	R. B. Kercheval, expenses	15 50
	Pay roll No. 11, Yuba cut-off	156 00
	Pay roll No. 12, Yuba cut-off	956 00
5—	Western Building Material Company, cement	222 25
	Rio Vista Telephone Company, telephone service	6 15
8—	Pay roll No. 13, Brannan Island	306 72
13—	R. B. Kercheval, expenses	1 30
	Western Hotel, Marysville, board and lodging	14 00
15—	Pay roll No. 14, Yuba cut-off	348 70
	Southern Pacific Company, freight	26 44
	Pay roll No. 15, Brannan Island	347 65
18—	W. F. Harms, drayage	3 00
	Friend & Terry Lumber Company, lumber	80 35
	The Schaw-Batcher Company, merchandise	241 46
	Jenkins & Wells, supplies	90 87
	Jenkins & Wells, for use of pile driver	210 00
	The Schaw-Batcher Company, merchandise	222 00
	McLaughlin Draying Company, drayage	15 08
	The Waterbury Company, wire rope	1,554 57
	Pay roll No. 16, Brannan Island	415 85
Mar. 10—	P. M. Norboe, expenses	2 50
	Fashion Stables, livery	7 50
	J. J. McCarthy, salary	62 50
	Baker & Hamilton, merchandise	18 86
	Kelly Bros, livery	2 00
	W. W. Wooldridge, inspector, salary	130 00
	Pay roll No. 17, Mokelumne River	179 00

RECTIFYING RIVER CHANNELS—*Continued.*

1908.		
Mar. 10—	Phœnix Livery Stable, livery	$30 00
	F. C. Miller, expenses	11 25
	Arthur Thornton, board and lodging	64 00
	N. Ellery, expenses	22 10
	R. B. Kercheval, inspector, salary	116 00
	Sacramento Transportation Company, freight	2 78
16—	The Schaw-Batcher Company, merchandise	94 65
	N. E. McInerney, steamer fare	7 00
	L. H. Brainard & Son, steamer fare	7 00
	Farmers' Transportation Company, steamer fares	14 00
	Dearing and Gilmore, board	5 70
	R. B. Kercheval, expenses	1 45
	H. Hoffman, team hire	2 50
	Pay roll No. 18, Tisdale weir	72 00
	Western Building Material Company, cement	768 25
	The Waterbury Company, merchandise	1,624 60
	Rio Vista Telephone and Telegraph Company, telephone service	2 15
	W. A. Elliott, lumber	5 00
	J. McCormack, merchandise	11 00
	L. H. Church, merchandise	3 00
	California Transportation Company, freight	32 47
	Bay Development Company, gravel	364 80
	Baker & Hamilton, merchandise	12 90
	W. W. Wooldridge, inspector, salary	260 00
	Pay roll No. 19, Brannan Island	431 74
	Pay roll No. 20, Brannan Island	301 68
April 4—	The Waterbury Company, prepaid freight	12 94
7—	E. A. Palm, brush	400 00
	Keuffel & Esser Company, merchandise	43 10
	F. C Miller, expenses	3 30
	Pay roll No. 21, Mokelumne River	326 38
	A. Thornton, board and lodging	84 75
	Phœnix Livery Stable, livery	45 00
10—	B. S. N. Myers, board and lodging	58 00
	F. W. Edson, team hire and feed	22 50
	Bay Development Company, gravel	348 00
18—	The Sacramento Union, advertising	16 80
	The Schaw-Batcher Company, merchandise	228 80
	N. Ellery, expenses	18 50
	Pay roll No. 22, Mokelumne River	56 00
	Pay roll No. 23, Brannan Island	341 40
	Pay roll No. 24, Sherman Island	119 75
	F. W. Edson, livery	20 00
	Don Ray & Co., 1 oar	1 25
	H. D. Shinn, boat hire	10 00
	B. S. N. Myers, board and lodging	45 25
	F. C. Miller, expenses	4 65
	Rio Vista Telephone and Telegraph Company, telephone service	1 80
	John Christensen, launch hire	71 24
	J. T. Brown & Co., merchandise	4 55
	Waterbury Company, merchandise	692 13
	Pay roll No. 25, Sherman Island	180 62
	P. M. Norboe, expenses	16 50
30—	Pacific Telephone and Telegraph Company, long-distance service	7 35
	J. Stern & Co., merchandise	4 00
	Fashion Stables, livery	6 00
	Southern Pacific Company, freight	89 62

RECTIFYING RIVER CHANNELS—*Continued.*

1908.		
April 30	—Mrs. Vera Winchester, typewriting	$2 50
	Eagle Stables, livery	6 00
	Baker & Hamilton, merchandise	9 71
	Jenkins & Wells, labor	12 75
	Waterbury Company, merchandise	909 25
	Sacramento River Supply Company, poles	35 00
	Western Building Material Company, cement	222 25
	N. Ellery, expenses	17 90
	P. M. Norboe, expenses	24 35
	J. J. McCarthy, salary	75 00
	The Schaw-Batcher Company, merchandise	33 95
	Keuffel & Esser Co., merchandise	71 81
	A. R. Vaughn, labor	9 00
	F. C. Miller, salary	150 00
	Pay roll No. 26, Brannan Island	196 24
	Pay roll No. 27, Merkeley	290 85
	Pay roll No. 28, Merkeley	408 93
May 1	—The Sacramento Union, advertising	11 55
	Hotel River View, board	3 00
	Cypress Villa Hotel, board and lodging	11 00
	W. W. Wooldridge, inspector, salary	229 67
8	—Mrs. Geo. Brown, typewriting	2 50
25	—Geo. W. Tatterson, expenses	11 85
June 4	—John Breuner Company, merchandise	15 00
	Pacific Telephone and Telegraph Company, telephone service	7 40
8	—Capital Machine and Auto Company, auto hire	20 00
	Fashion Stables, livery	2 00
	F. C. Miller, salary	150 00
	J. J. McCarthy, salary	77 50
	M. J. Boggs, expenses	34 30
	P. M. Norboe, expenses	21 35
9	—A. R. Vaughn, labor	7 88
	Harry Obitz, labor	12 50
	A. W. Campbell, blue prints	19 95
	Crawford Cox, salary	26 00
	Fashion Stables, livery	4 00
	F. C. Miller, salary	150 00
	J. J. McCarthy, salary	75 00
	Edward Goodwin, expenses	50
10	—N. Ellery, expenses	22 40
	F. H. Depew, labor	2 50
	E. C. Huestis, labor	9 00
	Pacific Telephone and Telegraph Company, telephone service	6 75
	W. W. Wooldridge, salary	17 33
	F. C. Miller, expenses	7 80
	Western Hotel, Marysville, board and lodging	23 70
	Wells, Fargo Company, expressage	16 50
	Rio Vista Electric Engineering Company, repairs	18 80
14	—N. Ellery, expenses	7 85
	P. M. Norboe, expenses	7 90
	E. K. Wood Lumber and Mill Company, lumber	13 82
	California Reclamation Company, dredging	1,094 36
18	—Keuffel & Esser Company, merchandise	20 80
29	—The Schaw-Batcher Company, merchandise	3 00
Aug. 18	—The Schaw-Batcher Company, merchandise	3 50
	H. S. Crocker Company, merchandise	30 85
	J. J. McCarthy, salary	77 50

RECTIFYING RIVER CHANNELS—*Continued.*

1908.			
Aug. 18—	Crawford Cox, salary		$27 00
	H. T. Rasmussen, merchandise		1 55
	P. M. Norboe, expenses		12 70
	F. C. Miller, salary		70 00
	W. W. Wooldridge, salary		21 65
	E. K. Wood Lumber and Mill Company, lumber		7 50
	J. T. Higgins, expenses		40 45
	Pacific Telephone and Telegraph Company, telephone service		3 70
19—	Marysville Levee Commission, clearing land		339 05
	W. L. Van Guelder, repairs to boat		46 70
31—	P. M. Norboe, expenses		15 85
	Pay roll No. 29, Yuba cut-off		669 37
Sept. 5—	Pay roll No. 30, Yuba cut-off		771 04
12—	Pay roll No. 31, Yuba cut-off		665 00
19—	Pay roll No. 32, Yuba cut-off		390 31
	C. J. Rhodin, drafting		90 00
	W. W. Wooldridge, inspector. salary		130 00
	J. J. McCarthy, salary		77 50
	Edward Goodwin, expenses		7 10
	Postal Telegraph Company, telegram		35
	Swift Bros. Planing Mill, stakes		1 00
	California Reclamation Company, dredging		2,489 72
Oct. 5—	California Reclamation Company, dredging		1,143 97
13—	J. T. Higgins, expense account		110 70
	Western Building Material Company, cement		952 50
	California Reclamation Company, lumber		7 26
	E. K. Wood Lumber and Mill Company, lumber		65 98
	P. Eckelmann, expense		65 60
	The Secramento Union, advertising		19 60
22—	Crawford Cox, salary		24 00
	E. Goodwin, expenses		7 15
	Miller-Chapin-Enwright Company, merchandise		1 50
	G. W. Kapp, merchandise		47 00
	W. W. Wooldridge, inspector, salary		130 00
	G. H. Nichols, salary		50 00
	J. J. McCarthy, salary		77 50
	Eugene Dietzgen Company, merchandise		21 10
	Fairbanks, Morse & Co., merchandise		15 85
26—	Western Bridge and Construction Company, repairs, Tisdale weir		752 00
	P. I. Welles, 10 per cent on Yuba cut-off work		249 57
	E. D. Griffith, cement testing		18 54
31—	Electrical Supply Company, merchandise		3 50
	Kelly Bros., livery		5 00
	N. J. Sligar, livery		5 00
	Miller-Chapin-Enwright Company, merchandise		4 04
	N. Ellery, expenses		24 20
	E. Goodwin, expenses		15 65
	E. D. Griffith, cement testing		11 35
	W. W. Wooldridge, inspector, salary		130 00
	G. H. Nichols, salary		50 00
	J. J. McCarthy, salary		77 50
	G. W. Kapp, merchandise		61 00
	P. M. Norboe, expenses		24 35
	Western Bridge and Construction Company, repairs, Tisdale weir		3,321 42
	Total expenditures to November 1, 1908		$43,498 32
1903—	Appropriation balance	$5,227 51	
1907—	Appropriation	125,000 00	130,227 51
	Balance		$86,729 19

RECTIFYING RIVER CHANNELS—*Continued.*

Rights of Way Appropriation.

1907.		
April 26	—Southern Pacific Company, steamer service	$200 00
May 20	—Western Union Telegraph Company, telegrams	72
31	—Pacific States Telephone and Telegraph Company, long-distance service	3 20
1908	—Total expenditures to November 1st	$203 92
1897	—Appropriation balance	214 52
	Balance	$10 60

EEL RIVER PROTECTION.

Expenditures, 1907-08.

1907.		
Aug. 19	—B. Emerson, labor	$1 37
	J. R. Williams, labor	1 50
	A. J. Harland, labor	1 50
	J. Reynolds, labor	16 50
21	—E. A. Light, team	13 00
	Richard Sweasey, team, feed	2 00
	Robt. Johnston, livery	21 50
	Mrs. C. W. Kramer, board and lodging	3 00
	G. C. Schilling, auto hire	50 00
	N. Ellery, expenses	32 35
23	—Waterbury Company, wire cable	174 15
Sept. 16	—Wright Wire Company, wire cable	168 19
17	—Western Building Material Company, cement	708 75
23	—Pay roll No. 1, labor	234 12
	W. A. Moore, driving piles	662 00
	F. W. Luther, wire and cement	461 57
	Northwestern Pacific Railroad Company, freight	6 48
	W. Overhulser, teaming	140 00
	Henry Maseman, teaming	145 00
30	—Pay roll No. 2 (east side), labor	862 74
	Pay roll No. 3 (west side), labor	1,103 19
Oct. 3	—Northwestern Pacific Railroad Company, freight	277 78
10	—Pay roll No. 4 (east side), labor	981 76
	Pay roll No. 5 (west side), labor	819 84
19	—Pay roll No. 6 (east side), labor	1,150 10
Nov. 1	—F. O. Grothe, board and lodging	4 00
	G. W. Conners, drayage	33 55
	Western Building Material Company, cement	444 50
	A. Robinson, brush	2,912 91
	Northwestern Pacific Railroad Company, freight	243 11
	H. W. Brown, livery	15 00
	N. Ellery, expenses	34 00
	Pay roll No. 7 (east side), labor	1,354 67
	Overland Freight Transportation Company, cartage	1 50
	Pay roll No. 8 (west side), labor	429 33
8	—Western Building Material Company, cement	444 50
	F. Vladya, auto hire	31 50
	C. W. Kramer, board and lodging	5 25
	Robert Johnston, livery	8 50
	S. A. Frank, board and lodging	3 00
20	—Pay roll No. 9, labor	1,815 65
	Pay roll No. 10, labor	1,146 37

EEL RIVER PROTECTION—*Continued.*

1907.			
Dec. 1—	Pay roll No. 11, labor	$675	09
31—	Steamer "Caroline," freight	2	50
Jan. 6—	W. J. Young, expenses	4	15
Sept. 24—	Pay roll No. 12 (west side), labor	908	85
	A. Robinson, brush	415	00
Oct. 31—	Pay roll No. 13 (east side), labor	994	93
	Frank W. Luther, wire	237	73
	A. Robinson, brush	907	20
	Pacific Lumber Company, lumber		58
	Total expenditure to November 1, 1908	$21,111	78
1907—	Appropriation	25,000	00
	Balance	$3,888	22

TRAVELING AND CONTINGENT.

1907.			
May 17—	N. Ellery, thumb tacks	$0	15
18—	N. Ellery, expenses	7	00
21—	F. W. Hatch, expenses	8	40
23—	N. Ellery, expenses	42	65
	H. E. Sleeper, rubber stamps	3	75
	Pacific Telephone and Telegraph Company, telephone	5	50
	W. F. Purnell, stationery	2	25
	Globe Transfer Company, drayage	2	50
June 1—	C. Alberti, salary	83	33
	G. E. S. Barnes, salary	73	33
	Chas. Prince, salary	26	66
	Wm. H. Davis, salary	26	66
	N. Ellery, expenses	9	25
	Western Union Telegraph Company, telegrams	1	98
4—	N. Ellery, expenses	11	50
8—	N. Ellery, expenses	17	45
	Architect's pay roll No. 1, drafting	253	38
9—	N. Ellery, expenses	3	15
	E. C. Hemmings, expenses	16	25
10—	Geo. C. Sellon, expenses	34	05
	Keuffel & Esser Co., merchandise	440	59
17—	N. Ellery, expenses	23	35
21—	Keuffel & Esser Co., merchandise	3	14
22—	John Breuner Company, merchandise	10	25
	N. Ellery, expenses	12	05
	W. H. Davis, salary	15	00
	B. C. Tarver, expenses	8	00
	Geo. C. Sellon, expenses	21	30
	Architect's pay roll No. 2, drafting	802	79
23—	E. C. Hemmings and W. D. Edwards, expenses	19	45
24—	N. Ellery, expressage		45
30—	Pacific Telephone and Telegraph Company, telephone service	16	65
	Scott, Lyman & Stack, merchandise	6	00
	Adolf Frese Optical Company, merchandise	10	00
	H. E. Sleeper & Co., stamps	19	25
	The A. Lietz Company, merchandise	140	40
	Clark Alberti, salary	125	00
	G. E. S. Barnes, salary	125	00
	Howard Cook, salary	6	66
	N. Ellery, expressage		85
	Chas. Prince, salary	44	00

TRAVELING AND CONTINGENT—*Continued.*

1907.		
June 30	W. Wooldridge, salary	$25 00
	P. M. Norboe, expenses	50 65
	W. Wooldridge, expenses	37 05
	Charles Johnston, salary	47 50
	J. J. McCarthy, salary	47 50
	J. B. Gray, expenses	37 67
	B. C. Tarver, salary	65 00
	N. Ellery, expenses	6 75
	C. H. Kluegel, salary	83 33
	Central California Electric Company, electric lights	1 00
	Mason's Steam Laundry, laundry	3 60
	Keuffel & Esser Co., merchandise	7 80
	Kane & Trainor Ice Company, ice	2 25
	W. F. Purnell, merchandise	35 70
	F. H. Fassett, drafting	25 03
July 2	W. D. Edwards, salary	20 25
	Chas. Prince, towel service	2 25
3	J. B. Gray, salary	95 00
	W. J. Young, expenses	3 90
5	J. E. Mayo, signs	7 00
6	E. C. Hemmings, expenses	13 00
July 7	N. Ellery, expenses	10 55
9	Geo. C. Sellon, expenses	60 70
	Architect's pay roll No. 3	633 77
	N. Ellery, expenses	16 65
15	Scott, Lyman & Stack, merchandise	1 60
	Capital-Sacramento Transfer Company, freight and cartage	4 50
	R. M. Richardson, Postmaster, stamps	10 00
	N. Ellery, expenses	26 65
16	F. H. Fassett, drafting	2 57
18	Keuffel & Esser Co., merchandise	14 70
31	Pacific Telephone and Telegraph Company, telephone service	22 55
	Crescent Blue Printing Company, blue prints	6 80
	Mason's Steam Laundry, towel service	2 00
	The Angelus, lodging	5 00
	Wells, Fargo & Company, express	50
	Francis S. Ott, merchandise	10
	Crescent Blue Printing Company, blue prints	10 00
	Hotel Crellin, lodging	2 00
	W. F. Purnell, merchandise	5 95
	H. E. Sleeper & Co., merchandise	3 50
	E. C. Hemmings, expenses	12 30
	W. D. Coates, expenses	11 00
	Geo. C. Sellon, expenses	15 20
	Architect's pay roll No. 4, drafting	736 27
	The A. Lietz Company, merchandise	140 00
	Chas. Prince, salary	10 00
	Howard Cook, salary	10 00
	Clark Alberti, salary	125 00
	G. E. S. Barnes, salary	125 00
	Mae Lezansky, typewriting	6 00
	Universal Drafting Machine Company, merchandise	36 25
	B. C. Tarver, expenses	3 90
Aug. 2	W. J. Young, expenses	1 80
	N. Ellery, expenses	14 85
	Geo. C. Sellon, expenses	15 16
5	Architect's pay roll No. 5, drafting	941 05

TRAVELING AND CONTINGENT—*Continued.*

1907.		
Aug. 12—	Statutory salaries, May and June	$2,532 65
	Central California Electric Company, electric lights	70
	H. S. Crocker & Co., merchandise	22 60
	The A. Lietz Company, merchandise	313 00
	F. R. Pulford, keys	5 35
	Central California Electric Company, electric lights	1 35
	Kane & Trainor Ice Company, ice	2 60
31—	Clark Alberti, salary	125 00
	Howard Cook, salary	10 00
	Chas. Prince, salary	10 00
	Keuffel & Esser Company, merchandise	82 77
	Western Union Telegraph Company, telegrams	1 63
	Wells, Fargo & Company, express	3 65
	Scott, Lyman & Stack, merchandise	4 70
	Mason's Steam Laundry, towel service	2 00
	Capital-Sacramento Transfer Company, drayage	2 50
	Crescent Blue Printing Company, blue prints	6 00
	Remington Typewriter Company, minute books	16 00
	H. T. Rasmussen, merchandise	4 25
	Scott, Lyman & Stack, merchandise	3 30
	W. F. Purnell, merchandise	35 20
	A. W. Campbell, blue prints	4 76
	Alfred Kuhn, expenses	43 25
	E. C. Hemmings, expenses	23 67
	Geo. C. Sellon, expenses	28 80
	Hotel Baltimore, lodging	3 00
Aug. 31—	R. M Richardson, Postmaster, stamps	5 00
	San Francisco Chronicle, advertising	2 00
	Crescent Blue Printing Company, prints	4 08
	Wells, Fargo & Company, express	1 90
	W. F. Purnell, merchandise	15 15
	Pacific Telephone and Telegraph Company, telephone service	36 85
Sept. 4—	B. C. Tarver, expenses	4 05
	G. E. S. Barnes, salary	125 00
	C. J. Rhodin, salary	60 00
	J. J. McCarthy, expenses	7 50
	J. J. McCarthy, salary	32 50
	Pacific Telephone and Telegraph Company, telephone service	75
	Architect's pay roll No. 6, drafting	45 30
	Western Union Telegraph Company, telegrams	1 25
	Kane & Trainor Ice Company, ice	2 70
	Mason's Steam Laundry, towel service	2 00
	P. M. Norboe, expenses	8 80
	George C. Sellon, expenses	40 10
	N. Ellery, expenses	17 65
	Paul Oakley, merchandise	30
6—	R. M. Richardson, Postmaster, stamps	5 00
7—	N. Ellery, auto hire	15 00
10—	San Francisco Chronicle, advertising	10 00
11—	Sacramento Electric, Gas and Railway Company, gas	.10
	Scott, Lyman & Stack, merchandise	8 55
14—	Architect's pay roll No. 7, drafting	48 55
16—	H. S. Crocker Company, merchandise	65
18—	H. E. Sleeper & Co., rubber stamps	6 40
20—	R. M. Richardson, Postmaster, stamps	5 00
24—	H. T. Rasmussen, merchandise	1 00
	W. Wooldridge, expenses	7 20

TRAVELING AND CONTINGENT—*Continued.*

1907.			
Sept.	26—	R. M. Richardson, Postmaster, stamps	$5 00
	27—	Keuffel & Esser Co., merchandise	41 54
	30—	Wells, Fargo & Company, express	6 22
		W. F. Purnell, merchandise	6 15
		Kane & Trainor Ice Company, ice	2 15
		Western Union Telegraph Company, telegrams	2 95
		Pacific Telephone and Telegraph Company, telephone service	40 85
Oct.	1—	Capital Transfer Company	2 01
		Clark Alberti, salary	125 00
		G. E. S. Barnes, salary	125 00
		Howard Cook, salary	10 00
		Charles Prince, salary	10 00
		B. C. Tarver, expenses	3 95
	2—	H S. Crocker Company, merchandise	5 00
		Architect's pay roll No. 8, drafting	83 66
		Chas. Prince, towel service	4 50
	5—	N. Ellery, expenses	6 60
		Central California Electric Company, electric lights	1 00
	8—	Geo. C. Sellon, expenses	66 65
		A. J. Johnston Company, merchandise	1 50
		Fairbanks, Morse & Co., merchandise	47 50
		Baker & Hamilton, merchandise	4 00
		Cresent Blue Printing Company, prints	6 74
		Mason's Steam Laundry, towel service	2 50
		B. C. Tarver, expenses	4 40
		W. J. Young, expenses	4 40
	10—	H. B. Traver, expenses	6 00
		Central California Electric Company, electric lights	1 45
	16—	Keuffel & Esser Co., merchandise	68 31
	17—	R. M. Richardson, Postmaster, stamps	5 00
	28—	Sacramento Auto and Machine Company, repairs	1 65
		Capital Transfer Company, drayage	3 55
		W. F. Purnell, merchandise	5 05
	31—	H. E. Sleeper & Co., rubber stamps	24 25
		Wells, Fargo & Company, express	12 69
		Geo. Sellon, expenses	38 74
		E. C. Hemmings, expenses	10 80
		G. E. S. Barnes, salary	125 00
		Clark Alberti, salary	125 00
		J. J. McCarthy, salary	20 00
		Howard Cook, salary	10 00
		Chas. Prince, salary	10 00
		N. Ellery, expenses	11 10
		Pacific Telephone and Telegraph Company, telephone service	34 90
		Elks' Hall Association, rent	40 00
		R. M. Richardson, Postmaster, stamps	5 00
		H. S. Smith, expenses	63 05
		H. S. Crocker Company, merchandise	21 00
		Scott, Lyman & Stack, merchandise	4 50
		Western Union Telegraph Company, telegrams	11 41
		Kane & Trainor Ice Company, ice	1 35
Nov.	2—	Scott, Lyman & Stack, merchandise	16 85
		Mason's Steam Laundry, towel service	4 50
		John Breuner Company, merchandise	11 05
	9—	N. Ellery, expenses	67 00
		Capital Transfer Company, drayage	75
	15—	R. M. Richardson, Postmaster, stamps	5 00

TRAVELING AND CONTINGENT—*Continued.*

1907.		
Nov. 16	Kueffel & Esser Co., merchandise	$142 90
	Crescent Blue Printing Company, prints	3 36
25	American Cash Store, merchandise	35
29	R. M. Richardson, Postmaster, stamps	5 00
	W. V. Stafford, expenses	7 50
30	Central California Electric Company, gas and electricity	1 25
	W. F. Purnell, merchandise	9 50
	Wells, Fargo & Company, express	9 42
	Home Transfer Company, drayage	10 00
Dec. 1	Chas. Prince, salary	10 00
	Howard Cook, salary	10 00
	Clark Alberti, salary	125 00
	G. E. S. Barnes, salary	125 00
	Pacific Telephone and Telegraph Company, telephone service	38 55
	Geo. C. Sellon, expenses	65 52
	Sacramento Electric, Gas and Railway Company, gas	90
	Keuffel & Esser Co., merchandise	336 80
	H. S. Crocker Company, merchandise	12 40
	Kane & Trainor Ice Company, ice	1 25
	F. H. Fassett, drafting	23 11
	B. C. Tarver, expenses	10 35
	Western Union Telegraph Company, telegrams	9 82
	John Breuner Company, merchandise	9 00
23	W. F. Purnell, merchandise	3 55
	Central California Electric Company, electric lights	90
	R. O. Kimbrough, merchandise	75
	Keuffel & Esser Co., merchandise	84 45
	Bessie Mugford, typewriting	41 25
	Capital Transfer Company, drayage	8 60
	E. C. Hemmings, expenses	32 65
	Geo. C. Sellon, expenses	26 20
	F. P. Walsh, expenses	2 90
	E. C. Huestis, labor	3 75
	Nathan & Michel, rent	30 00
	R. M. Richardson, Postmaster, stamps	10 00
	N. Ellery, expenses	41 55
	Silva & Company, coal and wood	13 00
	B. W. Gardner, keys	60
	A. W. Campbell, blue prints	4 15
	G. E. S. Barnes, salary	37 50
	Clark Alberti, salary	125 00
31	Charles Prince, towel service	4 50
	Pacific Telephone and Telegraph Company, telephone service	42 47
1908.		
Jan. 3	H. E. Sleeper & Company, dater	1 00
	Electrical Supply Company, merchandise	75
	McDowell & Harding, merchandise	30
	Chas. J. Noack, repairing clock	50
	B. C. Tarver, expenses	6 60
	Capital-Sacramento Transfer Company, drayage	7 39
	Western Union Telegraph Company, telegrams	1 14
	Eldred & Travers, drayage	5 00
	Pacific Grocery and Produce Company, merchandise	1 25
	McDowell & Harding, merchandise	15
	R. O. Kimbrough, merchandise	40
	C. J. Peters, merchandise	50
	H. S. Crocker Company, merchandise	65

TRAVELING AND CONTINGENT—*Continued.*

1908.			
Jan.	3—	Clark Alberti, salary	$125 00
		G. E. S. Barnes, salary	125 00
		R. M. Richardson, Postmaster, stamps	15 00
		Keuffel & Esser Co., merchandise	89 16
		Mason's Laundry, towel service	4 00
		Hotel St. James, board and lodging	5 00
		P. M. Norboe, expenses	30 75
		Sacramento Electric, Gas and Railway Company, gas	60
	23—	F. C. Chinn, merchandise	85
		Miller-Chapin-Enwright Company, merchandise	6 00
		Keuffel & Esser Co., repair work	3 00
		H. S. Smith, expenses	6 95
		McDowell & Harding, merchandise	1 25
		Silva & Company, merchandise	7 00
		Wells, Fargo & Company, express	14 58
		W. F. Purnell, merchandise	13 55
		Pacific Telephone and Telegraph Company, telephone service	34 20
		N. Ellery, expenses	75 80
		Geo. C. Sellon, expenses	120 11
Feb.	4—	F. R. Schaefer, drafting	71 98
		Scott, Lyman & Stack, merchandise	1 95
		W. de Mari, drafting	9 03
		E. Strassle, drafting	6 45
		F. P. Walsh, drafting	16 10
		W. Wooldridge, salary	57 50
		Cresent Blue Printing Company, prints	210 15
		Mason's Laundry, towel service	8 00
		Mugford & O'Leary, typewriting	10 75
		Wells, Fargo & Company, express	6 50
		G. W. Kopp, carpenter work	6 50
		B. C. Tarver, expenses	5 40
	21—	Western Union Telegraph Company	2 72
	28—	Geo. C. Sellon, expenses	50 67
		W. V. Stafford, expenses	8 50
		Electric Supply Company, merchandise	15 39
		W. P. Fuller & Co., merchandise	60
		Miller-Chapin-Enwright Company, merchandise	35
		Sacramento Gas and Electric Company	2 10
		W. F. Purnell, merchandise	23 85
		P. M. Norboe, expenses	18 80
		D. Dierssen Company, expenses	1 50
		Pacific Telephone and Telegraph Company, telephone service	35 75
		Keuffel & Esser Co., merchandise	19 90
		G. E. S. Barnes, salary	125 00
		Clark Alberti, salary	125 00
		Lynn & O'Neil, merchandise	6 90
		Ben W. Gardner, keys	1 20
		H. E. Sleeper & Co., merchandise	1 60
		R. Crandall, auto hire	4 00
		R. M. Richardson, Postmaster, stamps	15 00
Mar.	5—	N. Ellery, expenses	101 55
		Scott, Lyman & Stack, merchandise	1 95
		Alfred Kohn, expenses	3 60
		Willis & Martin Co., merchandise	15
		Crescent Blue Printing Company, prints	144 56
		G. E. S. Barnes, salary	125 00
		D. Dierssen Company, merchandise	90

TRAVELING AND CONTINGENT—*Continued.*

1908.			
Mar.	5—	Capital-Sacramento Transfer Company, drayage	$2 56
		Geo. C. Sellon, expenses	41 55
		F. P. Walsh, expenses	6 80
		Robertson Planing Mill, sink	22 96
		H. E. Sleeper & Co., rubber stamps	7 25
		R. M. Richardson, Postmaster, stamps	15 00
		Keuffel & Esser Co., merchandise	41 31
		Electrical Supply Company, merchandise	15 74
		Miller-Chapin-Enwright Company, merchandise	4 34
		C. J. Peters, merchandise	50
		B. C. Tarver, expenses	6 60
		Pacific Telephone and Telegraph Company, telephone service	26 90
	24—	N. Ellery, expenses	43 70
July	2—	E. D. Griffith, expenses	5 45
	3—	W. P. Fuller & Co., merchandise	35
		F. P. Walsh, expenses	5 05
		H. E. Sleeper & Co., merchandise	1 00
		Tunnison Map Company, map	2 75
		John Breuner & Co., merchandise	6 55
		Keuffel & Esser Co., merchandise	28 75
		Pacific Telephone and Telegraph Company, telephone service	3 85
		G. H. Nichols, salary	100 00
		G. E. S. Barnes, salary	125 00
	25—	N. Ellery, expenses	29 05
		R. M. Richardson, Postmaster, stamps	20 00
		Geo. C. Sellon, expenses	70 35
		P. N. Norboe, expenses	35 85
		F P. Walsh, expenses	13 75
		W. P. Fuller & Co., merchandise	1 43
		R. O. Kimbrough, merchandise	20
		Mason's Laundry, towel service	4 00
		D. Dierssen Company, merchandise	90
		Willis & Martin, merchandise	1 90
		Electrical Supply Company, merchandise	12 45
		Miss W. B. Ross, typewriting	9 90
	30—	Wells, Fargo & Company, express	39 30
		Western Union Telegraph Company, telegrams	4 10
		Capital Transfer Company, drayage	2 12
		H. S. Crocker Company, merchandise	16 50
		John Breuner Company, merchandise	2 34
		W. F. Purnell, merchandise	5 98
		Eugene Dietzgen Company, merchandise	97 15
		Keuffel & Esser Co., merchandise	114 21
Aug.	1—	Pacific Telephone and Telegraph Company, telephone service	33 50
		Geo. C. Sellon, expenses	51 55
		R. M. Richardson, Postmaster, stamps	30 00
		N. Ellery, expenses	106 25
		Klune & Floberg, repairs	50
		Johnston-Rablin Company, merchandise	75
		Electrical Supply Company, merchandise	2 50
		Mason's Laundry, towel service	4 00
		Wells, Fargo & Company, express	30 97
		G. E. S. Barnes, salary	125 00
		G. H. Nichols, salary	100 00
		F. Chinn, merchandise	1 00
		W. P. Fuller & Co., merchandise	60
		Smith, Emery & Co., merchandise	3 50

TRAVELING AND CONTINGENT—*Continued.*

1908.		
Aug. 1—	The A. Lietz Company, repairs	$2 50
	H. E. Sleeper & Co., merchandise	1 25
	H. S. Crocker Company, merchandise	32 00
	Miller-Chapin-Enwright Company, merchandise	6 54
	W. F. Purnell, merchandise	9 25
	Eugene Dietzgen, merchandise	54 70
	Braun Knecht-Heimann Co., merchandise	1 19
13—	Fairbanks, Morse & Co., merchandise	54 20
	Miller-Chapin-Enwright Co., merchandise	6 88
	Geo. C. Sellon, expenses	117 45
	Miss W. B. Ross, typewriting	1 68
	N. Ellery, stamps	15 00
	Johnson-Rablin Company, merchandise	1 50
	Capital-Sacramento Transfer Company, drayage	3 78
	H. E. Sleeper & Co., rubber stamps	50
	Wm. A. Langley, repairs	50
31—	G. H. Nichols, salary	75 00
	G. E. S. Barnes, salary	125 00
	Mason's Laundry, towel service	4 00
	P. M. Norboe, expenses	42 50
	Capital Auto Company, auto hire	24 00
	John Breuner Company, merchandise	50
	W. F. Purnell, merchandise	4 10
	Kirk, Geary & Co., merchandise	75
	W. P. Fuller & Co., merchandise	1 36
	Willis & Martin Co., merchandise	1 95
	F. P. Walsh, expenses	27 15
	H. S. Crocker Company, merchandise	31 00
	Pacific Telephone and Telegraph Company, telephone service	27 70
Sept. 30—	Wells Fargo & Company, express	30 09
	Western Union Telegraph Company, telegrams	10 42
	Eugene Dietzgen Company, merchandise	26 50
	Keuffel & Esser Co., merchandise	100 05
	Architect's pay roll No. 9, labor	256 38
Oct. 1—	R. M. Richardson, Postmaster, stamps	15 00
	H. S. Crocker Company, merchandise	20 75
	Mason's Laundry, towel service	4 00
	Pacific Telephone and Telegraph Company, telephone service	19 60
	Pioneer Garage, auto hire	12 00
	Wm. A. Langley, keys	70
	Keuffel & Esser Co., merchandise	39 38
	R. O. Kimbrough, merchandise	15
	H. E. Sleeper & Co., ink	50
	W. F. Purnell, merchandise	2 75
	Wells Fargo & Co., express	23 69
	Willis & Martin Co., merchandise	1 00
	Western Union Telegraph Company, telegrams	3 32
	Howard & Morse, merchandise	2 67
	A. S. Penfield, R. R. Blue Book	1 00
	Johnston-Rablin Company, merchandise	1 50
	Mason's Laundry, laundry	2 35
31—	P. H Norboe, expenses	50
	G. H. Nichols, salary	75 00
	Crawford Cox, salary	27 00
	G. E. S. Barnes, salary	125 00

TRAVELING AND CONTINGENT—*Continued.*

Date	Item	Amount
1908. Oct. 31—	F. P. Walsh, expenses	$9 00
	N. Ellery, expenses September and October	176 65
	Total expenditures	$17,911 22
	Appropriation fifty-ninth and sixtieth fiscal years	20,000 00
	Balance	$2,088 78

PRINTING.

Date	Quantity	Item	Amount	Total
1907, July —	200	Paper boxes (2)		$100 00
Aug. —	1,000	Labels	$3 25	
	2	Lettering books	1 00	4 25
Oct. —	500	Contracts	$69 00	
	2,500	Bill heads, Kings River	10 25	
	250	Pay rolls, Kings River	7 75	
	150	Pay rolls, Eel River	7 50	
	1,250	Bill heads, Eel River	7 00	
	2,000	Manuscript covers	15 75	
	5,000	Engineer inspector's report blanks	42 00	159 25
Nov. —	1,000	Time cards	$8 50	
	1,000	Cement tags	4 25	
	750	Cement test cards	25 00	37 75
Dec. —	5,000	Letter heads, T. W.	$18 75	
	7,000	Envelopes No. 6¼-10s	25 50	44 25
1908, Jan. —	200	Cement order blanks	$6 00	
	3,000	Building inspector's blanks	29 50	35 50
Feb. —	1,000	B. P. record cards	$21 50	
	1,000	Draughtsmen's time cards	8 50	
	3,000	Drawing index cards	14 50	
	5,000	Manuscript covers	35 50	80 00
Mar. —	10	Record books		45 50
April —	500	Salary expense blanks		5 00
May —	5,000	Letter heads, T. W.		22 50
June —	1,000	Draughtsmen's time cards	$8 50	
	2,000	Envelopes, No. 10	9 50	18 00
				$552 00
July —	5,000	Envelopes, No. 6¾	$14 25	
	2,000	Manuscript covers	16 50	
	2,000	Engineer inspector's reports	23 00	53 75
Aug. —	3,000	Inspector's requisitions	$17 50	
	10,000	Time cards	30 00	
	4,000	Segregation bill heads	31 25	
	5,000	Daily reports	36 00	
	300	Segregation sheets	25 00	139 75
Sept. —	5,000	Letter heads, T. W.		22 50
Oct. —	20,000	Time cards	$55 00	
	600	Monthly records	22 75	
	2,000	Manuscript covers	16 50	
	4,000	Envelopes, Nos. 6¾-10	17 00	111 25

Item	Amount
Total expenditures to November 1, 1908	$879 25
Appropriation fifty-ninth and sixtieth fiscal years	1,500 00
Balance November 1, 1908	$620 75

(Cost of printing Biennial Report not yet deducted.)

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